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An analysis of the effect of marital/dependency status on retention, promotion, and on-the-job productivity of male Marine Corps officers

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THESIS

AN ANALYSIS OF THE EFFECT OF MARITAL AND FAMILY STATUS ON RETENTION, PROMOTION, AND ON-THE-JOB PRODUCTIVITY OF MALE MARINE CORPS OFFICERS

by

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March 2005

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This thesis investigates the effect of marital and family status on the performance and job productivity of male U.S. Marine Corps officers. The analysis includes evaluation of fitness reports, retention, and promotion to O-4 and O-5 ranks as performance measures. The primary goal is to examine the existence of any marriage premium on officers' performance and productivity and to investigate potential causal hypotheses. The personnel database used for the analysis includes more than 27,000 male Marine officers who entered the Marine Corps between FY 1980 and 1999.

After controlling for selection, estimating fixed effects and using panel data in order to capture timely-varying effects, this study finds that there is a marriage premium for all performance measures. The thesis rejects the explanation that such premiums are due to supervisor favoritism. Moreover, married male officers obtain higher fitness report scores, higher promotion probabilities, and higher retention probabilities than single officers. Each additional year spent in marriage increases fitness report scores and retention probabilities. Having additional non-spousal dependents increase fitness report scores and retention probabilities. On the other hand, being a currently single but "to-be-married" officer yields higher premium, as married officers, for all productivity and performance indicators. This supports selectivity into marriage as a partial explanation of the source of the marriage premium.

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AN ANALYSIS OF THE EFFECT OF MARITAL/DEPENDENCY STATUS ON RETENTION, PROMOTION, AND ON-THE-JOB PRODUCTIVITY OF MALE MARINE CORPS OFFICERS

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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I. INTRODUCTION

The fact that married male workers earn more than single male co-workers is well established in labor economics literature. Studies indicate that a marriage earnings premium exists in a range from 10 to 40 percent. However, the source of this differential is still controversial.

Some studies explain that the wage premium exists because married male workers are able to specialize in labor market activities, while their wives (spouses) specialize in household activities. A related explanation, which is based on the lower cost of human capital acquisition for married men, is that married men make a greater investment in human capital. They anticipate that they will be able to recoup the benefits of such investment for a longer period of time since they think they will have to work a larger fraction of their lifetime than single male workers due to family responsibilities.

On the other hand, some studies attribute the marriage wage differential to factors other than human capital investments. One argument is that more productive workers are selected into marriage. Alternatively, employers may prefer married workers over single workers due to a perception that married workers are more responsible or stable. Another explanation is that marriage indicates certain unobservable individual characteristics, such as ability, honesty, loyalty, dependability, and determination, which are valued in both the labor and marriage markets. The explanation of the marriage wage premium is an important subject in labor economics because it can contribute to achieving a better understanding of the determination of individual wages and worker productivity.

The purpose of this research is to explore and identify any difference in the performance and productivity of U.S. Marine Corps officers that may be attributed to marital status or family structure. The analysis will include an evaluation of fitness reports, promotion to O-4 and O-5 ranks, and retention to 10 years of commissioning service (YCS). The primary goal is to obtain an unbiased estimate of marital and dependency status on male Marine Corps productivity by controlling for selectivity associated with the characteristics of officers who marry versus those who are single.

The scope of this research consists of six parts: (1) a review of previous studies; (2) an analysis of the basic characteristics of the dataset; (3) the development of appropriate hypotheses to address various explanations and types of marriage premium; (4) The estimating of models and the testing of hypotheses; (5) a summary major findings; (6) and a discussion of recommendations and limitations of the study and possible extensions.

The primary research question of this thesis is whether either marital status or family size has an impact on the productivity, promotion and retention of male Marine Corps officers. The source of any such potential premium is explored by secondary questions as to whether the source of a marriage premium is attributed to (1) the accumulated years of marriage or (2) selection into marriage. By analyzing accumulated years of marriage, we test whether the marriage premium can be explained by household specialization and human capital theories. By analyzing selection into marriage, we examine whether the premium is uniquely related to marriage or is caused by better performing officers' marriage decisions. Finally, the research analyzes whether the estimations in the study are affected by selection bias due to retention decisions of Marine Corps officers.

This thesis consists of the following discussions. Chapter I introduces the problem, purpose, and scope of the thesis and presents the research questions and organization of the thesis. Chapter II presents findings about the existence of a marriage premium and summarizes major hypotheses about the source of the marriage premium by reviewing existing studies. Chapter III describes the personnel system of U.S. Marine Corps officers (officer promotion, up-or-out policy, and promotion tournament system), officers' family life, the basic characteristics of the data, and construction of the variables. This chapter provides preliminary analysis of the data by focusing on the marital-status-related variables. Chapter V explains the hypotheses tested in the study and presents model specifications and hypothesized effects of the variables. Finally, Chapter VI summarizes the major findings of the study, recognizes limitations of the thesis, and provides recommendations for further research.

II. BACKGROUND AND LITERATURE REVIEW

A. INTRODUCTION

Analyzing the determinants of wages, as a proxy for productivity, is a popular subject in labor economics. Of all the examined determinants, marital status has been found to be one of the most robust ones. Kol and Ryu (2002), in their survey of the literature, indicate that estimates of the marital wage premium in previous studies range from 10 to 40 percent.

Since it is difficult to find direct data on job productivity per employee, most studies use proxies that are more readily available. Based on an assumption that the labor market is competitive, profit-maximizing employers optimize their incentives for production by compensating employees based on their marginal productivity (Ehrenberg and Smith, 2003), which supports the rationale to use earnings as a proxy for on-the-job productivity.

On the other hand, some studies use performance ratings and job grades to measure of on-the-job productivity. Korenmark and Neumark (1991) utilize such proxies for the first time to analyze the marriage premium for employees of a single firm. They assume that, within a given grade level, those with high performance ratings or high rankings were more productive than those with low performance ratings or rankings. They rationalize their assumption by pointing out that a job's grade reflects its relative value to the company, and positions of similar value are placed at the same classification level. A justification is established for performance ratings, which are given by supervisors who are instructed to rate employees on current performance and contributions based on the requirements of their present assignments. The following section describes the techniques and measures used in the literature.

B. ALTERNATIVE EXPLANATIONS OF THE MARRIAGE PREMIUM

The source of the marriage premium is a controversial issue among labor economists. Many analyses test the various explanations and much evidence has been presented for each hypothesis. Keeping in mind that there is no dominant explanation

among these tested hypotheses, such explanations help economists construct a framework for better understanding the effect of marriage on the job productivity of workers.

Explanations of the marriage premium can be categorized according to whether or not the premium is associated with higher productivity caused by marriage. There are two explanations that indicate that marriage directly increases productivity. One is that marriage causes household specialization in which the husband specializes in market activities. The second explanation is that marriage causes faster human capital acquisition by the husband during marriage. There are also three arguments why marriage is not the cause of the premium. These explanations are based on selectivity into marriage, employer discrimination, and marital matching.

1. Marriage Increases Productivity

Gary Becker (1981) was the first to claim that married men are more productive than single men in labor economics. He states that there is a direct relationship between the time spent in a particular economic activity and the incentive to invest in human capital specific to that activity. He also asserts that within a household there is a division of labor based on the initial differences in comparative advantage between men and women in the labor market and in the home. To minimize opportunity costs, husbands specialize in labor market work and wives in nonmarket work. Therefore, such specialization will generate an advantage for married men in the form of a productivity difference between them and nonmarried men.

In her well-cited study, Hill (1979) claims that marriage makes men more productive. Controlling for many qualifications, she suggests that the probable reason for the unobserved 25% to 50% marriage premium is not unobservable individual characteristics, but rather, the increased productivity due to marriage.

Later, Korenman and Neumark (1991) deduce that marriage is a dynamic productivity-enhancing event in a man's life. They find not only that selectivity into marriage can explain only 20% of the premium, but also that the number of years of marriage is also important in understanding the source of the premium, a finding that opposes selection bias explanations.

Chun and Lee (2001) also find that marriage makes men more productive. Testing Becker's theory versus the selection hypothesis, they find no evidence to support the selection hypothesis; gains from marriage are positively associated with the degree of specialization within the household.

In one of the most recent and most innovative studies on the subject, Antonovics and Town (2004) use data on monozygotic twins to examine the selection hypothesis. Assuming that such data allow them to control for unobservable heterogeneity, the authors estimate a 26-percent marriage premium. They point out that this result is "robust to alternative specifications of the wage equation and various attempts to control for measurement error." Their conclusion is that marital status has a causal effect on men's wages.

Regarding the military labor market, Kol and Ryu (2002) also find that marriage increases both retention and productivity of male officers in a fertile dataset of U.S. Navy officers who entered the Navy between 1976 and 1985. Because of the varying job characteristics in the Navy, they divide their sample into two subsamples: Unrestricted Line Officers (URL) and Staff and Restricted Line officers (STF/RL). Their regression results indicate that the married men in both sub samples achieved higher performance ratings, higher promotion, longer service retention, and more graduate education than single officers. However, results are smaller for STF/RL than for URL officers. Although they attribute some portion to selectivity into marriage, their fixed-effects results indicate that the positive effect of the marriage premium is still robust.

a. Marriage Makes Men More Productive Because of Household Specialization

One argument that explains how marriage makes men more productive is Becker's (1973) household specialization model. His theory is based on two assumptions: (1) that each person tries to do as well as possible, and (2) that the "marriage market" is in equilibrium. According to Becker, a household will attempt to maximize its total output and therefore will tend to make a division of labor within the household for both market and non market labor activities. He explains this willingness as:

> …even a multi-person household has a single well-ordered preference function. For, if one member of a household – the "head" – cares enough about all other members to transfer resources to them, this household would act as if it maximizes the "head's" preference function, even if the preferences of other members are quite different. (Becker, 1974, p 17)

Consequently, all else equal, the division of labor will result in more human capital investment and more job experience in favor of married men as compared to single men whose status limits the possibility for a division of labor. Thus, the specialization model suggests that married men are more productive and will therefore be paid more than single men.

Korenman and Neumark (1991) also agree with the specialization theory. They hypothesize that, if Becker's formulation is correct, the marriage premium will also have a dynamic structure. In other words, since a greater duration in marriage would cause more specialization in labor market activities, the effect of marriage on on-the-job productivity (and wages) will increase with additional years of marriage. Their cross-sectional findings show that each additional year of marriage increases wages 2.3 percent in the early years of marriage and roughly 1-2 percent at the mean of years married.

Specialization theory strongly suggests that the time wives devote to producing household commodities is important for determining married men's specialization in labor activities. One available proxy used in studies to determine wives' time devoted to household activities is their market work hours. However, this proxy may have a varying effect on husbands' time spent on housework. Hersch and Stratton (2000) suggest that married men with employed wives may spend more time on housework than men whose wives are not employed. They emphasize that there are two components that affect the time married men spend in housework activities. One is the increase in household income, which decreases their time in household work, and the other is the increased value of their wives' time, which increases the men's their time in housework. The net effect of the proxy will depend on the magnitude of these two components.

Based on this reasoning, examining wives' work hours will provide a better understanding of the specialization hypothesis. Gray (1997) shows that men whose wives worked in the labor market full-time earned five percent less than men whose

wives work in home production. Chun and Lee also find that the earnings of married men decreased by about 0.1 percent for each additional hour worked by their wives in the labor market, a result that supports Becker's theory. On the other hand, Loh (1996) and Jacobsen and Rayack (1996) present contradictory findings in their studies. Holding marriage length and other variables constant, Loh shows that married men with wives who devoted more time to the labor market received a higher marriage premium than those whose wives did not work at all. Similarly, taking into account that there may be an inherent endogeneity problem between a husband's wage and his wife's work hours, Jacobsen and Rayack state that the premium that was initially obtained from cross-sectional Ordinary Least Squares (OLS) estimates in favor of single-earner husbands is eradicated or significantly dampened by adjusting for simultaneity.

As an alternative to the marital lifestyle, cohabitation is also examined by econometricians to understand the nature of the marriage premium, since cohabitation is based on a more gender-balanced household division of labor (Cohen, 2002 citing from South and Spitz, 1994). Providing less financial responsibility, the cohabiting lifestyle is an increasing trend in the United States. Cohen (2002) recognizes that there is a relation between the growing population of cohabitors and the decline in the marriage premium from 1976 to 1999. He shows that controlling for cohabitation reduces the rate of decline by 35 percent for white and black men.

Stratton (2002) also examines the nature of the marital and the cohabitation wage premiums for men by estimating wage models that permit both differential wage growth and selection effects. She utilizes data from the National Survey of Families and Households (NSFH). In this survey respondents were interviewed first in 1987-1988 and again in 1992-1994. She restricts her analyses to white, non-Hispanic men under 65. She obtained 3,281 observations for the first survey and 2,515 for the second, on which she conducts both cross-sectional and panel analyses.

Stratton concludes that "both the marital and cohabiting wage differentials are statistically significant with currently married men earning about 22 percent more and currently cohabiting men earning about 13 percent more than the base group of men who have never married and cohabited. Neither past marriage nor past cohabitation appears to

significantly influence wages" (p.206). According to the cross-sectional results, differences in education, experience, and other explanatory variables explain about two-thirds of the raw marital-wage differential of 56 percent. Further, Stratton divides cohabiting men into two separate groups: those cohabiting for more than 3 years and those cohabiting less than 3 years. She finds that only men in long-term cohabiting relationships experienced a wage gain that was similar to that of married men. She concludes that "men do not receive a wage benefit from all joint household operations, but instead that marriage has a nearly unique effect on men's productivity." However, she does not attempt to explain the source of this "unique" premium.

Cohen provides another reason for the decline in marriage premium: the increasing trend in wives' contribution to the labor market. Cohen states that, from 1976 to 1999, the amount of wives' annual hours contributed to the labor market increased by 39 percent, while husbands' contributed annual hours increased only 8 percent. If the household specialization theory is true, the more married women spend their time in labor market activities, the more their husbands do house work. And the more time married men spend in housework activities, the less time and energy they will have to specialize in labor market activities, which will lower the marriage premium. Therefore, the relation between the increasing trend in wives' annual hours in the labor market and the downward trend in husbands' marriage premiums is evidence for the household specialization theory.

Kol and Ryu (2002) also find evidence for the household specialization theory in their study. According to their findings the more years URL male officers had been married, the better their performance ratings and the higher their promotion rates. However, STF/RL male officers received better performance ratings when they had fewer years of marriage. According to Kol and Ryu, "since staff officers spend more time at home than line officers, many of whom are deployed overseas, staff officers devote more time to household production" (p.94).

b. Marriage Makes Men More Productive Because They Invest More in Human Capital

Another argument to explain why marriage increases the productivity of men is that married men invest more in human capital, which results in higher

productivity and higher wages. Two explanations are suggested in order to explain faster human capital acquisition. First, family responsibilities make married men more future-oriented. Anticipating that they will spend more time in labor market activities, married men are willing to invest more in human capital than single men. Hence, they expect to harvest the benefits of their investment for longer periods. The second explanation is that married men can finance their investment in human capital from their spouses' earnings at borrowing rates below those available outside the family.

Kenny (1983) attributes wage growth rates to the additional investment in human capital that takes place during marriage. He interprets the intercept in his statistical estimates as the average additional human capital investment during years married. However, he doesn't present any direct evidence to support his claim. Hill (1979) shows that, on average, married men spent more time than single men in training on their current job. Loh (1996) points out that Lynch (1992) statistically confirmsthat married people are more likely to receive company or on-the-job training. On the other hand, Cornwell and Rupert (1997) cast doubt on the idea that married men have faster human capital acquisition because Bergstorm and Schoeni (1992) reported earlier that men and women with more formal education tended to marry later than those with less education.

Kol and Ryu (2002) also examine the human capital theory of the marriage premium. They use graduate education attainment as an indicator of human capital investment because, "since firm-specific training and tenure are the same for all Naval officers, graduate education is the only human capital investment that officers can make" (p.95). Their regression results indicate that married officers make higher investments in human capital.

2. Marriage Does Not Increase Productivity

Although the wages of married men are higher than those of single men, that premium may not be caused by marriage. Testing two explanations of how marriage makes men more productive, Loh (1996) and Cornwell and Rupert (1997) find evidence against these arguments. Loh demonstrates that there is no male marriage premium between single-earner and dual-earner marriages. However, according to the specialization theory there should be an additional marriage premium for husbands in

single-earner families. He also finds that time spent with the wife before marriage has no effect on the marriage premium. This finding contradicts the specialization model.

Using the same dataset for a longer period, Cornwell and Rupert (1997) contradict Korenman and Neumark's (1991) findings. Cornwell and Rupert suggest that marriage is not productivity enhancing, but a pure intercept shift in productivity that is no greater than five to seven percent. This finding contradicts the specialization theory because more specialization in market activities should lead to faster wage growth with longer marital duration.

a. Marriage Premium is Caused by Selectivity Into Marriage

The selectivity hypothesis is that marriage does not make men more productive. Instead, men who are, or who will be, more productive get married. In general, people marry when they believe that the perceived value of marriage is greater than that of staying single. Therefore, people who perceive potentially good prospects within marriage will be more likely to marry. Consequently, these prospects will turn into economic differences that will be observed as marriage premia for married men. Ginther and Zavodny (1998) propose another, yet similar, selectivity story by emphasizing that since women may be reluctant to marry low earners, men's earnings may affect (be endogenous with) their own marital status.

According to Narkosteen and Zimmer (1987), there is a joint endogeneity problem that results from a potential correlation between the factors that influence both marital status and earnings. However, they also emphasize that these factors may be unobserved by the researcher, which will eventually cause missing variable bias in the estimates of the marriage premium. In order to control for this possible endogeneity, they use instrumental variables estimation on cross-sectional data. They find that the magnitude of the marriage premium is unchanged, but it becomes statistically insignificant. They interprete this finding as evidence that the marriage premium is due to selection.

Korenman and Neumark (1991) point out that selectivity explains only 20 percent of the estimated impact of the marriage premium in their findings. However, they also emphasize that the remaining impact may contain a more complex selection process

not corrected by fixed effects. For example, men with more rapid wage growth (rather than men with a higher wage level) may be more likely to marry.

Cornwell and Rupert (1997) claim that the marriage premium results from unobservable individual effects. Their results show that single men who will marry in the future earn at least as much as those who are already married. They attribute this result to the explanation that married men have characteristics valued in both the marriage and the labor market, such as ability, honesty, loyalty, dependability, and determination.

Ginther and Zavodny (1998) examine the selection hypothesis using a "natural experiment" that may make marital status uncorrelated with earnings ability for some men. They estimate the effect of "shotgun" (forced) weddings on earnings of married men. They assume that the likelihood of premarital conception is a substitute for the likelihood that the couple marries at random. This assumption helps them eliminate unobservable, potentially more "qualified," characteristics of men who will marry. They first find an apparent marriage premium in the cross-sectional analysis. However, it disappears in the fixed-effects results. They also show that, in both fixed-effects and cross-sectional regressions, married men with a premarital conception receive a lower marriage premium. They interpret these findings that the marriage premium for married men without premarital conception is caused by their higher wage-earning characteristics, in other words, the marriage premium is due to selection bias.

Kol and Ryu (2002) analyze selection into marriage by comparing single officers who will marry in the future and the single officers who will remain single in the future. They find a consistent marriage premium between these two groups for both STF/RL and URL male officers. However, by using fixed-effects methods in order to correct for unobservable individual characteristics, they are still able to obtain approximately a 10-percent performance ratings premium for both sub-samples. Thus,

Kol and Ryu claim that "at least some portion of the higher performance of married officers that are attributed to marriage is due to potentially more successful officers choosing to marry" (p.96).

Antonovics and Town (AT) (2004) attempt to identify the casual effect of marital status on earnings by using data on monozygotic (MZ) twins, which helps them control for unobservable heterogeneity. They use data from the Socioeconomic Survey of Twins. Although they had data on 487 male twin pairs, only 280 pairs were MZ pairs. They selected individuals who worked 26 weeks per year, who worked at least 20 hours or at most 100 hours per week, and who earned above $4.25/hour (the Federal minimum wage in 1994) or below $60/hour. After dropping 116 twin pairs due to missing values and an additional 28 twin pairs due to their sample-selection criteria, AT ended up with only 136 pairs eligible for the sample. In their analyses, besides marital status, they also include schooling, tenure at the current job, region, and age of the twins.

In their cross-sectional results, AT report that married men earned a 19-percent higher wage than unmarried men, all else equal. However, when they estimate this difference within the twins only, the coefficient becomes larger and reveals a 26-percent wage difference in favor of married men. Additionally, they report that the estimated wage premium was above 21 percent when the wage was at a first full-time job or was the wife's full-time work experience, or when the number of children was included in the models. They claim that their findings do not support the selection hypothesis and they conclude that marriage causes men's wages to rise.

Antonovics and Town's study is valuable as an innovative approach, one that rules out the selection hypothesis. However, AT are not able to reject the employer favoritism hypothesis with their findings. In addition, although they claim that their sample has similar characteristics with the 1995 March supplement of the Current Population Survey, there are only 31 pairs who differ in their marital status within the sample of 136. This number is barely acceptable for statistical analyses.

b. Marriage Premium is Caused by Employer Favoritism

One last argument about the source of the marriage premium is that this premium results from employers' preferences for married workers over single ones. According to this hypothesis, employers perceive that married men have more responsibilities and that those responsibilities cause them to be more stable and to work harder. These perceptions may be much stronger when supervisors are older and more likely to be married themselves.

Another aspect of the employer favoritism argument, suggested by Pfeffer and Ross (1982), is that married men are rewarded because they conform to social expectations that men should be married and support their families. Single men and married working women are penalized because they do not conform to this norm. They also hypothesize another explanation for employer preference, which is also stated by Loh (1996). According to this second hypothesis, the presence of wives allows married men to build better social relations and networks with their superiors that eventually pay off in better job ratings, faster promotions, and faster wage growth.

Emphasizing that employers' wage decisions are in part based on paternalistic attitudes that make them feel that workers who have greater financial responsibilities deserve higher wages, Hill (1979) suggests that the wage differential of married men may be a result of employer discrimination. She also points out that employers may not be responsible for the discrimination. Employees who are under pressure of greater financial responsibilities may be more adamant in demanding higher wages for themselves.

Testing the earnings differential among self-employed workers, Loh (1996) examines whether employer favoritism explains the marriage premium. According to his formulation, if the marriage premium is not due to supervisor discrimination, then a positive marriage premium should be observable in both self-employed and salaried workers. His results show that self-employed married men earn less than self-employed single men. He claims that this result supports the argument that the marriage premium is due to employer favoritism. Loh also refers back to Korenman and Neumark (1991) and

points out that the faster-wage-growth finding of Korenman and Neumark is also consistent with employer favoritism toward married workers.

c. Marriage Premium is Due to Marital Matching

Jacobsen and Rayack (JR) (1996) find that self-employed workers, a group that is not subject to the discriminatory behavior of supervisors, earn less when their wives work in the labor market than when their wives do not. Although this finding is consistent with the household specialization theory, their sophisticated statistical models result in a new explanation for the marriage premium (and the marriage penalty): marital matching. This theory suggests that the apparent marriage premium is caused by a particular form of attachment in which men with positive labor characteristics marry women who have less attachment to the labor market.

They use three different estimation techniques, in all of which the natural log of hourly wage is the dependent variable and the wife's paid work hours is the variable of interest. In their models, they also control for demographic factors, occupation, experience, and education. Ordinary Least Square estimates show a substantial premium for men with a non-working wife. However, when they use the number of children in the household, the age of the youngest child, the age of the wife, and dummies for the wife's educational attainment as instruments in the two-stage instrumental variables models, the premiums "disappear or actually reverse to a wage penalty for having a non-working wife among nonprofessional, non-managerial workers" (p.271). Although instrumental variable model results may reflect that there are complementarities in market production between husbands and wives or the ability of the husband to search more carefully for a good job match if the wife is providing income for the household through market work, JR strongly point out that the importance of these results is the disappearance of the negative impact of wives' work found in earlier studies for managers and professionals. Finally, the use of the fixed-effects technique to control for marital matching causes the premium for single-earner husbands to be dampened or to disappear completely. In light of these results, they claim that there is little evidence of employer favoritism or productivity difference explanations for the marriage premium and they provide a new explanation:

> …the results suggest that there is a particular form of marital matching in which men with positive labor-market characteristics pair with women who have less attachment to labor market. These results demonstrate that marital matching is an additional explanation for the apparent single-earner wage premium in the OLS estimates. (p.272)

Although JR do not mention the drawbacks of using data on self-employed workers, Loh (1996) presents three problems in such data: (1) self-employed workers are more likely than wage workers to understate their earnings to lower their tax liability; (2) their reported income may represent returns to physical capital; and (3) their business losses and gains incurred may be reported as part of their labor market earnings.

C. STUDY OF MILITARY PERSONNEL

1. Anderson and Krieg (2000)

Anderson and Krieg (AK) (2000) analyze the marriage premium for U.S. first-term enlisted male Marines. Their study is the first to analyze marriage in the military. They obtained data on 65,535 Marines provided by U.S. Marine Corps Headquarters, Manpower and Reserve Affairs Department, Manpower Plans and Policy Division. After eliminating women, missing observations, and Marines that re-enlisted, 44,103 observations remain in their sample.

Anderson and Krieg state that Marines of higher ranks (E-3 (Lance Corporal) and E-4 (Corporal) are evaluated and promoted according to their proficiency and conduct scores as well as the time spent in their current rank and their time in service. Although Marines of lesser ranks (E-1 (Private) and E-2 (Private First Class) are also assigned proficiency and conduct scores, their promotion is mostly based on time-in-service. Proficiency scores measure technical skills, specialized knowledge, leadership, initiative, and dependability, while conduct scores measure military bearing, attitude, obedience, and integrity. One would assume that Marines with higher proficiency and conduct scores would be more likely to be promoted. The descriptive statistics in the research indicate that single Marines have lower Armed Forces Qualification Test (AFQT) scores and lower physical fitness test (PFT) scores, have served in the military longer, are on average older, and are generally evaluated better in proficiency and conduct terms.

Using probit models to calculate the effect of marriage on the probability of promotion to the next grade, AK find a 4.7-percent higher probability to promote from E-3 to E-4 for married male Marines than their single counterparts. They also find that married Marines without dependents have a higher promotion probability than married Marines without dependents, which is contrary to the supervisor favoritism theory. The perception of supervisors about married personnel should not change, whether these personnel have dependents or not. AK also estimate a greater probability of being promoted for divorced Marines than single Marines. But divorced personnel in the Marine Corps are different from divorced civilian workers since they receive a great amount of support from counseling services and they live on military bases where they do not do housework. Therefore, AK do not represent this finding as a contradiction of the household specialization theory.

AK also implement heteroskedasticity-corrected OLS models in order to estimate the effect of marriage on proficiency and conduct evaluation scores. They find that marriage positively influences both scores. According to the results married Marines receive 0.04 points higher proficiency scores and 0.035 points higher conduct scores than single Marines. In order to protect their readers from falling into the perception that these scores are too small, AK emphasize that even a one-tenth of a point increase in proficiency scores increases a Marine's probability of being promoted from E-3 to E-4 by 1.38 percent. This difference is even larger when the fact that the promotion probability is compounded across multiple promotions is considered. Similar to the probit model estimates, married Marines with dependents again tend to score lower proficiency and conduct scores.

AK test the relationship between the promotion probability and evaluation scores and find a positive relationship. In other words, the higher the scores a Marine gets from his supervisor, the more likely he will be promoted. Thus, they conclude that the source of the marriage premium in Marines' promotion probability is the higher evaluation scores given by supervisors to married Marines. However, AK do not provide a specific reason for this conclusion. Since they don't implement sophisticated statistical techniques to eliminate selection bias, they can only suggest that the reason may be either married Marines' higher productivity or the selectivity of more productive Marines into marriage.

2. Mehay and Bowman (2004)

In the most recent and thorough study of the marriage premium, Mehay and Bowman (MB) (2004) analyze "the existence and magnitude of on-the-job productivity differentials between married and single male employees" (p.1) and "provide evidence on competing explanations for any marriage-related performance differentials" (p.1). They use data on navy officers, based on an administrative dataset that covers male U.S. Naval officers who entered the Navy between 1977 and 1985. The quasi-longitudinal data enables them to track the officers through their first 10 years of service or until they separate. The data contains detailed information on marital status and career performance, including promotion outcomes and annual appraisals by supervisors. MB examine staff and line (operational) officers separately because staff officers receive shorter formal training and fill mostly administrative and support jobs, while line officers receive longer formal training periods and fill jobs in aviation, on ships, and on submarines.

MB constructed three separate performance indicators. Their first two performance indicators are based on performance ratings given by supervisors during two different career periods. Of 25 different graded items and some other additional items in those performance ratings, "recommended for accelerated promotion" (RAP) is validated as a predictor of job performance. Thus, they use receipt of an RAP as the indicator of performance. Their third performance measure is promotion. MB emphasize that pay is not a reliable productivity in the military since "the military uses explicit fixed-length employment contracts and current pay is based largely on time-in-service with no adjustments for within-grade performance" (p.6).

MB find that married line officers receive 7.2 points (24%) higher ratings (RAP's) than their single counterparts and that married staff officers receive 5.9 points (16%) higher than single staff officers in their early-career stage (years 1 through 4) . In the later-career stage (years 4 through 10), male line officers who are married at the beginning of the career stage receive a 6% (4 point) advantage in subsequent appraisals received during the same career stage. Similarly, married staff personnel receive a 5% (3.3 point) advantage. According to MB, since the prolonged family separation of line officers would tend to shift household tasks to the wife, the results, which indicate that

the premium is smaller for staff officers, are evidence in favor of the specialization hypothesis. They also analyze the effect of divorce on productivity and find that the results for divorced line officers are consistent with the specialization hypothesis. That is, divorced men would display higher productivity than single men, since human capital accumulated during marriage does not depreciate instantly after the divorce. However, in the staff, there was no difference between divorced men and never-married men.

MB also find evidence for the positive dynamic effect of marriage. Their results show that line officers who are married for longer periods have a 3.7 point greater advantage on later-career ratings than those who first marry during the early-career period. Although continuously married staff personnel have a 5.1 point performance premium, the effect of recent marriage in this group is insignificant. MB also point out that there is a significant effect of having children. However, they emphasize that the effect of length of marriage on performance is independent of the presence of children.

MB use a different dataset to test for employer favoritism. This dataset contains information for 8,535 male surface specialists (within the line group) who are required to pass skill qualification tests in their specialty within 24 months of entering the Navy. These officers either passed within 24 months, or may have needed an extension and eventually passed the exam later, or may have failed and were transferred to a different specialty. Their findings were similar to their previous results. Surface personnel who were married at the entry point had on-time pass rates about 7 percentage points higher and eventual pass rates about 12 percentage points higher, than single men. These results are both economically and statistically significant.

In their third performance measure, MB find that married line officers are 13% more likely to promote, while the promotion premium is 8% for staff officers. Again, they find that the premium increases with marital duration.

MB also analyze selectivity issues. Differing from other studies, they analyze selection bias due to turnover. This type of selection bias exists if those who quit before the up-or-out promotion review are non-randomly selected. For example, if either poor performers, whose promotion chances are below average, or good performers, whose above-average skills provide them superior civilian job prospects, leave the navy at

higher rates, selection bias may exist. In models, the marriage coefficient of later-career performance rating models falls by about 20% in both groups (as compared to the baseline probit results). Additionally, the estimated impact of marriage on promotion of line personnel in the selection adjusted model falls by about half compared to the baseline promotion probit model. On the other hand, the impact for staff officers becomes insignificant.

MB examine selection into marriage by comparing performance differentials between single male officers who will marry in the future and single officers who will stay single in the future. "To-be-married" single personnel performed slightly better than those who will stay single. More important, MB point out that currently married male officers performed much better than their "to-be married" currently single counterparts. They deduce from this result that selection hypothesis appears to explain only a small portion of the marriage productivity premium estimates.

Overall, MB provide a thorough analysis of the marriage premium explanations through an internal dataset that eliminates the influence of establishment-specific experiences. A potential lack of generalizability of the results based on navy personnel is compensated by greater precision. On the other hand, MB argue that the Navy personnel system appears to share many features of large, hierarchical organizations with highly structured internal labor markets, and thus a wider application of the results may not be as limited as it might appear.

D. CHAPTER SUMMARY

Almost all of the previous studies agree that there is a robust empirical marriage premium. However, they do not reach a common explanation for the marriage premium. Disagreement stems from either methodology or the data used. Cross-sectional results such as Hill (1979) and Kenny (1983) do not rule out the selectivity of higher earning men into marriage. On the other hand, two-stage models such as Narkosteen and Zimmer (1987) and Chun and Lee (2001), and fixed-effects methods such as Korenmark and Neumark (1991), Gray (1997), Stratton (2002), and Antonovics and Town (2004) can deal with the selectivity problem but cannot test for employer favoritism. Loh (1996) and

Jacobsen and Rayack (1996) were able to leave out employer discrimination by using data on self-employed workers. But a common weakness of prior studies, and one reason the controversy has not been solved, is the lack of information on the direct productivity of workers.

III. DATA

A. INTRODUCTION

This chapter discusses the Marine Corps personnel system and compares it with civilian personnel systems. The objective of this approach is to ensure the validity of the criteria used to measure the effects of marital status on the job productivity of USMC officers in the study. This chapter also describes the data source and presents basic descriptive statistics. The purpose of the preliminary analysis presented in this chapter is to better evaluate the effect of marital status on the productivity of male US Marine Corps Officers as measured by performance measures such as retention, promotion, and physical fitness reports.

1. USMC Personnel System

Similar to the personnel systems in other military services, the Marine Corps' personnel system exhibits features characteristic of an internal labor market, with a vertical hierarchy, administrative pay setting, and up-or-out promotion (Bowman and Mehay, 2004). Another feature of the USMC personnel system is promotion tournaments, such as are commonly used within the context of internal labor markets to motivate workers (Ehrenberg and Smith, 2000). There are 10 possible grades throughout the career of a USMC officer and every officer enters the system at the O-1 level. The system does not allow lateral entry and all promotions are from within the organization (Bowman and Mehay, 2004).

2. USMC Officer Promotions

A cohort of officers consists of all officers commissioned in a particular year. Officers move through their careers competing for promotion against other members of their cohort. USMC officers are generally considered for promotion to the next grade by a promotion board in accordance with the guidelines on promotion points in the Defense Officer Personnel Management Act (DOPMA) of 1980.

The USMC officer promotion process has three main elements: eligibility, selection, and promotion. These are interrelated and driven by: (1) authorized strength— the number of officers in a particular category specified for a grade or combination of grades; (2) promotion flow point— the number of years of commissioned service at

which most officers would be promoted to the next higher grade; and (3) promotion percentage—the number of officers in the promotion zone to be selected. These factors are interrelated and cannot be separated from each other. Table 1 shows promotion flow points and success rates for USMC Officers.

Table 1. Promotion Flow Points

Pay Grade	Rank	Time in Service	Process	Success Rate
O-2	1st Lieutenant	2 years	Fully Qualified	Nearly 100%
O-3	Captain	4 years	Best Qualified Selection Board	95-100 %
O-4	Major	9-11 years	Best Qualified Selection Board	80 %
O-5	Lieutenant Colonel	15-17 years	Best Qualified Selection Board	70 %
O-6	Colonel	21-23 years	Best Qualified Selection Board	50 %

Source : USMC Professional Career Development Center

Although the success rates given in Table 1 are the target rates according to the statistical analysis based on the MCCOAC data used in this study, actual success rates are somewhat lower than the targeted rates. These rates are calculated according to the number of officers who are considered by the promotion boards. For example success rate for promotion to O-4 is calculated by dividing the number of officers which are promoted to O-4 with the number of officers who are considered by the O-4 promotion board. Actual rates are presented in Table 2.

Table 2. Actual Promotion Flow

Pay grade	Rank	Time in Service	Success Rate
O-3	Captain	2 years	97 %
O-4	Major	4 years	78 %
O-5	Lieutenant Colonel	9-11 years	80 %
O-6	Colonel	15-17 years	55 %

Source: Author's computations from MCCOAC data base

According to DOPMA guidelines, the standard career progression for a typical or so-called due-course officer would be a promotion to O-4 at 10 years of service, O-5 at 16 years, and O-6 at 22 years. When officers are promoted at those promotion points, their promotions are said to be in the "primary zone" of the promotion system. The

majority of officers receive their promotions in the primary zone. A small number of officers who show outstanding leadership potential may be promoted a year earlier. Their promotions are referred to as "below-the-zone" promotions. Officers who are passed over for promotion in the primary zone can be reconsidered for promotion a year later. Successful promotions at this point are referred to as being "above the zone." [1]

Therefore, each cohort is considered for promotion to the next grade at least three times and at three different points: below the zone, in the primary zone, and above the zone. A promotion board typically promotes a small number of officers below the zone, the majority of officers in the primary zone, and a small number above the zone. The promotion opportunity to a particular pay grade, or the success rate, is computed by adding the number of officers selected for promotion from below, in, and above the primary zone and then dividing that sum by the total number of officers considered for promotion in the primary zone.

As seen in Table 1, nearly all officers in the system promote to O-2 and O-3. The first level where competition occurs is at 10 years of service. Prior to this point, officers make an important decision between staying in and leaving the system. Promotion evaluations occur within each major occupational specialty (MOS) to achieve the target officer inventory or end-strength. Officers are evaluated based on their performance in their previous job, skill qualifications, leadership and achievements, and prior annual performance ratings. Of those who decide to stay to the board, those who promote to O-4 are guaranteed 10 more years of service and a pension (Bowman and Mehay, 2004).

The officer inventory is shaped as a pyramid with many junior officers forming the base and a few senior officers on the top. This structure is due to the challenge of promotion in higher ranks and the decision to continue or quit after O-3. The Defense Officer Personnel Management Act determines the number of O4-O5-O6 USMC officers who can be retained as a percentage of the officer corps (RAND, 1994). A promotion becomes effective when a vacancy opens during the fiscal year following the year that officers are selected for promotion.

[1] The actual success rate seems to be lower than the projected ones. The main reason for these differences is the missing values that are kept in the sample but not used in the calculations of promotion rates. See the variable construction section.

3. Comparison of the Civilian Market with Navy Working Environments and Performance Criteria

The working environment and performance criteria utilized in all military branches are similar to those of the civilian market. Two studies that compare the personnel system of the Navy with the civilian branches are Kol and Ryu (2002) and Mehay and Bowman (2004). Characteristics of the Marine Corps working environment are very similar to that of the Navy; both are quite different from the civilian workplace.

According to Kol and Ryu, using military data to analyze job performance has both advantages and disadvantages. The main advantages are the job content, the difficulty level of each particular job, and career paths in the military. These features are very similar for all service branches. Another advantage is the common characteristics of military officers. Therefore, fewer controls are needed to capture individual-specific unobservable characteristics in order to estimate reliable models using officer data. Further, since unobservable characteristics of officers vary less than those of civilian workers, a claim of self-selection bias that is attributed to various unobservable characteristics of each individual is weakened. The existing job rotation in the military often affects an officer's performance appraisal and makes it more objective. The structure of the military allows an officer to be evaluated by different supervisors every two or three years and thus automatically decreases the chance of supervisor-specific evaluation bias.

On the other hand, there are several disadvantages of using a population consisting of officers. In a civilian organization the supervisor is quite often the owner cares more about the performance of employees and consequently evaluates them more carefully and more objectively. However, in a military organization, the supervisor may not gain or lose anything directly from mis-evaluating the performance of an officer. The military is a public entity and supervisors are not owners. Thus, military supervisors may not care about the success of the organization as much as their civilian peers do. This claim is reinforced, especially in the old fitness-report system, by the high average

(inflated) ratings and the similarity of evaluation reports for different officers. In a civilian environment the reward and punishment systems work quickly. By contrast, in the military, a highly hierarchical and bureaucratic structure complicates rewarding and punishing officers.

Another disadvantage of using military officers to assess performance is that most of the skills required for the jobs are gained from military training programs. It is not easy to track an officer's accumulated human-capital investment. Moreover, officers do not have as many opportunities to invest their human capital on their own as do their civilian peers. However, the fact that firm-specific training is similar for all officers means that this characteristic is negatively homogenous.

Another issue of military data hinges on the indicators of on-the-job productivity. Although the three indicators based on fitness reports, retention, and promotion are commonly used to measure an officer's productivity, they are accepted as indirect proxy measures. Another issue is the "up-or-out" promotion system in the military. Promotions are highly dependent on vacancies in the next grade. For example, if few vacancies exist, successful officers may be passed up or forced to leave. At the other extreme, officers with poor performance may be promoted if there are many openings in the next grade. In both cases, the promotion outcome may not be an ideal indication of an officer's productivity.

Mehay and Bowman (2004) also mention the advantages and disadvantages of using military data for analyzing the effect of marital status on employee job productivity. One of the main strengths is that several performance measures are available for each worker and the indicators capture performance throughout an employee's tenure rather than at a single career point. In addition, different than civilian data, military data controls for some key aspects such as career ladders, job assignment, and promotion policies.

Mehay and Bowman (2004) also mention that "military data are minimizing the effects of unmeasured firm heterogeneity and individual heterogeneity by controlling for differences in jobs, occupations, and labor supply, all of which may differ by marital status." However, on the other hand, they also mention that "the tradeoff in using internal

data is that greater precision in estimated effects is often obtained at the expense of generalizability." Shared features of the Navy's and private firms' personnel systems are stated by them as:

> Tenure in the lowest three grades is between 3 and 4 years, promotion to grade 4 is a crucial point for career advancement, and upper level jobs (above grade 4) are characterized as pertaining to general management, managing larger groups, coordinating across units, or strategic planning. (Mehay and Bowman, 2004)

B. DATA SOURCE

The data used in this study consists of information about Marine Corps officers who were commissioned between the years 1980-1999. The raw-data file itself was obtained originally from the Center for Naval Analysis via Professor William Bowman at the U.S. Naval Academy. The dataset was constructed by following the methods in Ergun (2003). The main data file was shaped by first combining two datasets: the Marine Corps Commissioned Officer Accession Career (MCCOAC) data file and Marine Corps annual fitness report files. Since the USMC performance evaluation system was modified after 1999, fitness report files gathered between the years 1980-1998 are classified as "old" fitness report files, and the ones gathered between the years 1999-2001 are classified as "new" fitness report files. Only old fitness reports are used in this study. The MCCOAC data file and fitness report datasets were combined by matching the Social Security Numbers (SSN) of each individual.

After forming the data in a wide (longitudinal) format, we converted it to a long (panel) format. Both panel and longitudinal data are used in the study. We use longitudinal data for promotion and retention models since we focus on different specific time points, such as promotion to O-4 and O-5. However, panel data is preferred for observing the potentially time-varying effect of marriage and the number of non-spousal dependents on each of the 20 Marine Corps officer cohorts. It is used in both the PI and the supervisor favoritism models. Table 3 and Table 4 present examples of the two data formats. In the panel data format, the time variable is created by using ranks. Thus, each individual has up to 5 observations depending on their retention and promotion. After this transformation, we are able to eliminate individual-specific characteristics of each officer.

Table 3. Wide (Longitudinal) Format

Social Security Number	Marital status O-1	Marital status O-2	Marital status O-3	Number of Dependents O-1	Number of Dependents O-2	Number of Dependents O-3	Comm. Age
111111	S	S	M	0	0	1	22
222222	M	M	M	2	2	2	23

Table 4. Long (Panel) Format

Social Security Number	Time	Marital Status	Number of Dependents	Comm. Age
1111111	1	S	0	22
1111111	2	S	0	22
1111111	3	M	1	22
2222222	1	M	2	23
2222222	2	M	2	23
2222222	3	M	2	23

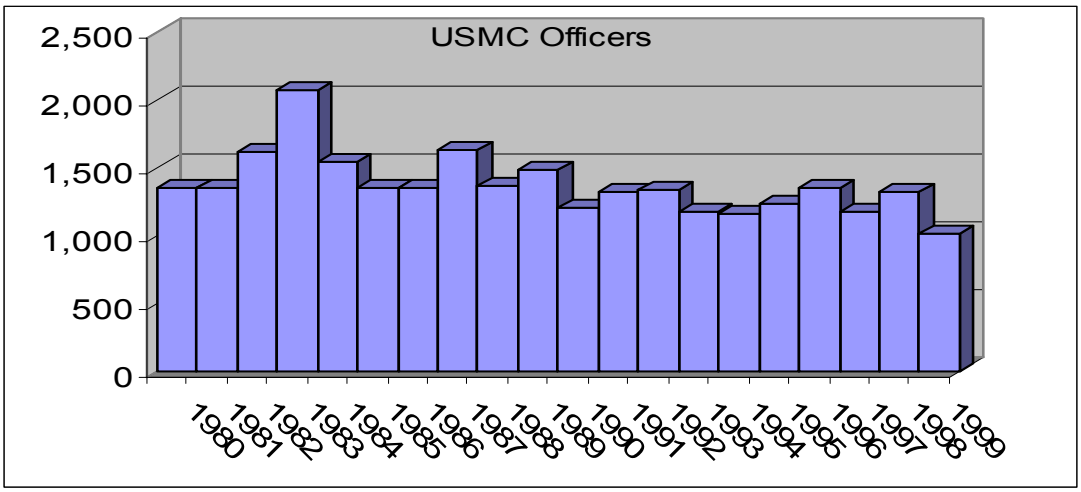
Since subjective appraisals may be open to favoritism, one approach to test for employer discrimination is to examine a more objective output indicator (Mehay and Bowman, 2004). For an objective indicator, we add the actual physical fitness, pistol and rifle scores, to the data derived from the MCCOAC file. The main objective of adding this information is to create variables that cannot be manipulated by supervisors. Since supervisors do not control these scores and they are direct measures of military performance, this information provides an opportunity to examine the marriage premium more objectively and to test for employer (supervisor) favoritism.

The data contains the marital status of each Marine Corps officer at several different points: (1) at entry; (2) at O-1; (3) at O-2; (4) at O-3; (5) at O-4; and (6) at O-5. Because of the lack of certainty of marriage and divorce dates in the data, we assume that the recorded marital status at these ranks reflects the status in the middle of the rank. However, since the dependent variables capture performance throughout the period, the marital status used is the one for the previous period, which also is at the beginning of each career period. According to this assumption, for example, when performance through O-3 is considered, we use the marital status at O-2, which provides certain information on the marital status at the beginning of service as an O-3.

1. MCCOAC Data Set

The MCCOAC data set contains 20 cohorts and includes 27,458 observations. The last observation date for each individual is 30 September 2000. Cohort sizes for different fiscal years are presented in Figure 1.

Figure 1. Cohort Size by Year



Since the main interest in this study is the effect of marital and dependency status on promotion, retention, and the job productivity of USMC officers, we first compute the changes in marital status by rank. Table 5 presents married officer percentages at each rank together with the percentage changes between the ranks. It seems from Table 5 that there are quite enough shifts in marital status, from not married to married, beginning from the early-career points (O-1) going towards the senior ranks (O5). The percent of officers married in each grade rises from only 30% in O-1 to 93% in grade O-5.

Table 5. Percent Married by Rank

Rank	Number of Cohorts Available	Average % of Married Officers and Computed % Increases
O-1	20	30.89 %
O-2	19	44.61 % (13.72 % increase)
O-3	17	61.10 % (16.49 % increase)
O-4	11	86.10 % (24.91 % increase)
O-5	5	93.14 % (7.13 % increase)

Source: Author's computations from MCCOAC data base

Promotion to O-4 is the up-or-out decision point in the system. The percentage increase of married officers from O-3 to O-4 is really remarkable according to Table 5. The average USMC officer commissioning age[2] is found to be 23, and on average USMC officers are 27 years old when they are O-3. Since most of them build a career until this point and are young enough to get married, this period is very suitable for marriage. Similarly from O-4 to O-5 there is also a high increase in the percent of married individuals.

Table 6 presents some statistics about the number of married and not married officers at O-3, O-4, and after the O-4 point.

Table 6. Marital Statuses, Retention, and Promotion

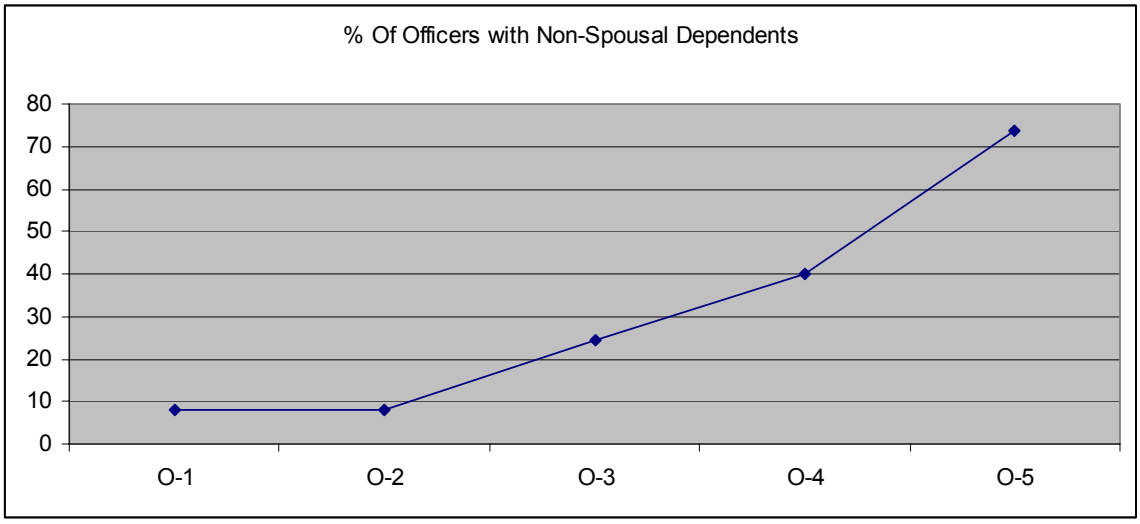
Marital Status	**Promoted O-3**	**Stay O-4 Board**	**Promoted O-4**	**Retention Rate**	**Promotion Rate**
Married	7,673	5,973	4,934	.78	.83
Not married	8,821	3,126	2,514	.35	.80

The number of officers who do not stay until the O-4 promotion board are the officers who voluntarily leave. If we combine the results presented in Table 5 and Table 6, we can say that married officers are more likely to stay in the military and married officers are very dominant at later ranks.

A second interest of the study was the change in the dependency status or number of dependents. Figure 2 presents the general trend of non-spousal dependency status throughout the careers of the U.S. Marine Corps officers.

[2] Commissioning age varied from 21 to 29 in the data. The average age is used here.

Figure 2. Non-Spousal Dependency Status



Similar to the trend in marriage, the number of U.S. Marine Corps officers who have non-spousal dependents constantly increases throughout an officer's career. This increase is quite logical given the high correlation between marriage and having children. Another point of concern may be the decision to leave or stay. Table 7 presents statistics about officers who are at the retention decision point.

Table 7. Dependency Status, Retention, and Promotion[3]

Dependency Status	Promoted O-3	Survived to O-4 Board[4]	Promoted O-4	Retention Rate	Promotion Rate
With Dependents	4,284	3,124	2,859	.73	.92
Without Dependents	13,372	6,235	4,703	.47	.75

It seems from the table that officers who have non-spousal dependents stay at higher rates than officers who do not have non-spousal dependents.

2. Old and New Fitness Report Data Files

The old fitness report data files are also used by Ergun (2003). The old fitness report data file consists of information on reporting senior (RS) markings for the 20 items

[3] Dependents here do not include spouses.

[4] Total number of officers who are promoted to O-4 and who survived O-4 board are more than the same total numbers presented in Table 6. The main reason for this difference is the missing marital status and number of dependents values in the data. Available marital status values are less than the available number of dependents values.

in Section B of the fitness reports. The old fitness reports include information on fitness reports submitted until the year 1998, and there are 27 fitness reports per officer on average in the data.

The U.S. Marine Corps began to use the new fitness reports officially after 1999. Both Ergun (2003) and Lianez and Zamarripa (2003) used these data in their studies. The last file in the data is dated August 2001. The new fitness report data file consists of reporting senior (RS) evaluations on 14 traits in the new fitness reports and each officer has 3 new fitness reports, on average. However, since the new fitness reports are so few and cover only two years of observations, only old fitness report files are used in this study.

3. Construction of Variables

There are three types of dependent variables in this study. These are PI, promotion and retention variables. Marital status, dependency status, accumulated years of marriage, and the to-be-married status are the focus variables. For other variables included in the models, we used variables defined the same way the same way as in Ergun (2003) used to create his variables.

a. Performance Index Variables

Performance characteristics (item 13) and professional qualities (item 14) graded in the Fitreps are selected for the construction of the PI. Performance characteristics consist of regular duties, additional duties, administrative duties, handling officers, handling enlisted personnel, training personnel, and tactical handling of the troops sub items. Professional qualities include endurance, personal appearance, attention to duty, military presence, cooperation, initiative, judgment, presence of mind, force, leadership, loyalty, personal relations, economy of management, and growth potential sub items. In the original dataset these items are graded qualitatively in 6 different levels that range from unsatisfactory to outstanding. In order to make a quantitative research, we converted these grades from 1 to 6 and then took the average of these sub-items. Grades that are marked “Not Observed” are converted as missing. Since there is more than one fitrep per person within the same rank, the average of the outcomes of these fitreps is taken and converted to 0-100 scale in order to create PI.

b. Promotion to O-4 and O-5 variables

Promotion to O-4 and promotion to O-5 variables are created as dummy variables that show whether officers were promoted to these ranks or not. Officers who have last-pay-grade information regarding these ranks are accepted as promoted. If an officer does not have available last-pay-grade information, we checked whether the this officer has the dates of acquiring these ranks in his records. We improved the accuracy of the promotion variables by examining the MCCOAC dataset, which helps to verify if the officer has a recorded fitrep in these ranks. Finally, for the fourth grade we accepted officers promoted to major who have served more than 120 months. The fifth grade is not appropriate for such correction by using number of months served since there is no time limit for serving in O-4.

c. Retained 10 Years in Service Variable

The 10 year retention in service variable is created as a dummy variable that shows whether officers were retained 10 years or not. Since 10 years in service requires 120 months of service time, the officers who served more than 120 months are accepted as retained.

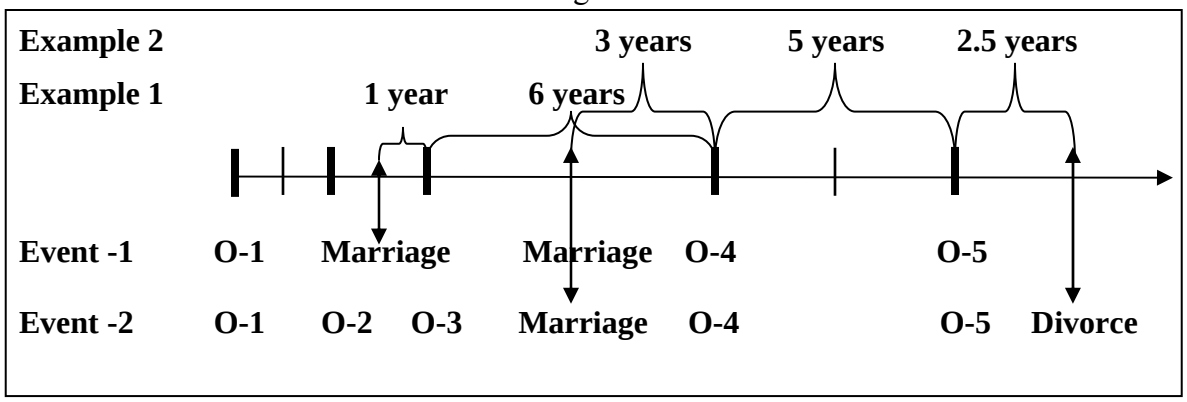
d. Focus Variables

The Headquarters Master Files (HMF) provides information about marital status and the number of dependents at different time points for each officer. We converted marital status information into dummy variables that represent being married or not at each rank. In order to test the difference between currently married and those currently single who will be married in the future, we created a "to-be-married" dummy variable. This variable is formed by observing if an officer who is single at the current rank will be married at a later rank or not. Additionally, for the supervisor favoritism model, matches between marital statuses of supervisors and officers are created as dummy variables.

In order to test the dynamic structure of marital status or performance we created a continuous variable that shows the accumulated years in marriage. The assumption we used here is that a marital status change occurs in the middle of the time spent in each rank. Table 8 displays the logic behind the calculations of accumulated marriage years in the following examples. Suppose, for example, an officer is recorded as

unmarried at O-1, married at O-2, and married at O-3. In computing the accumulated years in marriage up to O-4, we assumed that this officer accumulated 7 marriage years. Of these 7 years, 1 year comes from O-2 and 6 years from O-3. Similarly, suppose that an officer is recorded as unmarried at O-1 and O-2, but married at O-3 and O-4 and finally divorced at O-5. We assumed that this second officer accumulated 10.5 marriage years. Of these 10.5 years, 3 year comes from O-3, 5 years from O-4 and 2.5 years from O-5 until the divorce point, which is supposed to be in the middle of the period.

Table 8. Accumulated Marriage Years Variable Construction



The number of dependents is already provided in the raw data. However, this information includes spouses as dependents. In order to obtain the number of non-spousal dependents, we subtracted one from the number of dependents if the officer is married at that point.

C. SAMPLES FOR STATISTICAL MODELS

In order to better measure the potential affects of marriage on the retention, promotion, and on-the-job productivity of USMC officers, this study utilizes different officer samples for each performance model. Each sample is described below.

1. The Sample for the Performance Index (PI) Models

Although the traits used in the evaluations and the grading scales are different in old and new fitness reports (fitreps), since the results with new fitreps are generally insignificant we analyzed only the old fitreps. For old fitness reports 5 different PI variables were created for each rank. Table 9 explains the total number of observations available for each sample used to analyze the old fitrep performance index.

Table 9. Sample Sizes for Old Fitness Report PI

Explanation	Sample Sizes				
	O-1	**O-2**	**O-3**	**O-4**	**O-5**
Cohorts	1980-1997	1980-1995	1980-1994	1980-1990	1980-1983
Sample Size	27,458	22,697	17,656	8,165	1,526
Observation number	18,312	20,151	14,904	5,059	454

2. The Sample for the O-4 Promotion Model

The sample used for the promotion model is similar to that for the retention model and also includes information for officers who were accessed between FY 1980 and 1990. The sample consists of 16,351 officers. As Ergun (2003) mentions, although the data do not include promotion board results, we can measure the number of months to the O-4 date of rank. Over the years, promotion time to O-4 fell from 144 months to 113 months.

Of the 16,351 initial entrants in this sample, 10,158 survived until the O-4 promotion board. Nevertheless, the statistical analysis reveal that, 8,165 USMC officers out of 10,158 promoted to O-4. Sixty-six percent of those who promoted to O-4 were married, whereas 34% were not. The promotion success rate is 42.2% for the entry cohort as a whole and 80% for the officers who survived until the promotion board.[5] Table 10 summarizes the steps taken to reach the final dataset.

Table 10. O-4 Promotion Model Sample

Explanation	Observations	Percentage of Initial Sample
FY 1980-1990 Cohort	16,351	100 %
Missing Values	174	0.01 %
Officers who did not Survive O-4 Board	6,019	36.8 %
Final Sample Size	10,158	62.1 %
Officers who Promoted to O-4	6,908	42.2 %

3. The Sample for the O-5 Promotion Model

This sample includes information on officers in the 1980, 1981, 1982, and 1983 cohorts. There are 3,294 total observations in the sample. The statistical analysis revealed that the promotion time to O-5 fell from 212 months to 191 months for this sample. Of the 3,294 initial entrants in this sample, 2774 survived until the O-5 promotion board and

[5] See Table 2 For actual success rates .

1,526 promoted to O-5. The success rate is 46.3% for the entry cohort and 55% for the officers who survived until the promotion board.[6] 88.24% of the officers who promoted to O-5 are married; the rest are not married. Table 11 summarizes the steps mentioned above.

Table 11. O-4 Promotion Model Sample

Explanation	Observations	Percentage of Initial Sample
FY 1980-1983 cohort	3,294	100 %
Missing Values	174	5.2 %
Officers who did not Survive O-5 Board	346	10.6 %
Final Sample Size	2,774	84.2 %
Officers who Promoted to O-4	1,526	46.3 %

4. The Sample for the 10 YCS Retention Model

This sample includes information belonging to officers who accessed between FY 1980 and 1990. The initial sample consists of 16,351 officers. Of these 16,351 USMC officers, 7,438 left the military before reaching 120 months of service and 6,908 officers stayed. The remaining 2,005 officers have missing 10-year retention values. Since retention is a voluntary decision, 2,514 officers who were involuntarily discharged due to health problems, failure in basic training, or failure of promotion to O-2 or O-3 are deleted. The final dataset contains 13,837 observations. Table 12 summarizes the steps taken to reach the final dataset.

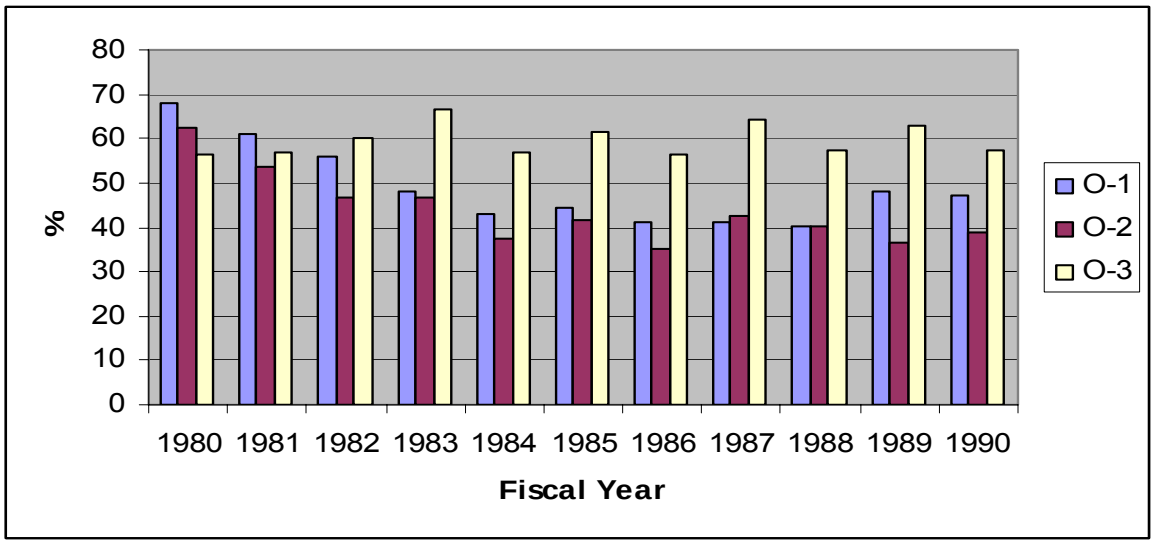
Table 12. 10 YCS Retention Model Sample

Explanation	Observations	Percentage of Initial Sample
FY 1980-1990 Cohort	16,351	100 %
Missing Values	2,005	12.3 %
Officers who left involuntarily	2,514	15.3 %
Final Sample Size	**11,832**	**73.4 %**
Officers who retained 10YCS	**6,908**	**42 %**

Similar to the analysis presented in the MCCOAC data file section, Figure 3 shows the percent of married officers over time. It seems that the probability of marriage as an event reaches the highest point before the retention decision for most fiscal years.

6 See Table 2 For actual success rates.

Figure 3. Married USMC Officer Percentages



5. The Sample for the Supervisor Favoritism Model

In this study we tried to test whether there is any supervisor favoritism and, if so, whether it explains any potential marriage premium. We use direct observations for supervisor favoritism. Each supervisor is tracked and their marital status information is derived from the HMF files. Their marital status of each reporting senior (supervisor) is matched and compared with the officers they rated by benefiting from MCCOAC dataset. The intention was to examine whether any potential bias arises when the marital status of the supervisor and the officer match. The hypothesis of supervisor bias would be supported, for example, if married reporting seniors are more likely to rate married officers more favorably.

While constructing the sample for this analysis, we first acquired information about fitness reports for all officers in different ranks from the MCCOAC dataset. The initial MCCOAC dataset contains 1,223,479 fitness reports. We excluded 417,378 fitness reports submitted for situations in which the supervisor worked less than 3 months with the officer who was evaluated.[7] By comparing the HMF dataset with the MCCOAC dataset, we matched 110,112 observations including officers' demographic information and reporting seniors' marital status at the rank they submitted the fitness reports. Finally,

[7] Marine Corps Order P1610.7E restricted 90 days of work as a limit for filing a fitness report. Fitness reports based on performance appraisals through a period less than 90 days are declared as not so valuable.

we excluded 18,459 observations due to missing fitrep values. Table 13 presents a summary of the steps used to construct the analysis sample.

Table 13. Supervisor Favoritism Sample

Explanation	Number of Officers	Number of observation per officer	Percentage of officers
FY 1980-1999 cohort	27678	1-26	100 %
Reports submitted for less than 90 days work period	4291	1-7	15.5 %
Observations that do not match	7102	1-13	25.6 %
Missing Fitrep values	1514	1-3	5.4 %
Final Sample Size	14771	1-18	53.36 %

In the final sample, 14,771 officers have a total of 91,653 fitness reports. 67,874 of these fitness reports were done by married reporting seniors and 23,779 were done by unmarried seniors. Since a majority of the reporting seniors have long work experience and are older, this statistic is quite logical. Table 14 summarizes the distribution of the observations by the rank and marital status of the reporting seniors (RS) versus the marital status of the recorded officers (RO). This sample does not include the fitreps of the recorded officers who are in grade O-5, because the marital status of officers in higher ranks than O-5 is not available in the HMF dataset.

Table 14. Distribution of Fitreps by rank and by marital status of RSs and ROs

Explanation	O-1	O-2	O-3	O-4
Married RS to Married RO	14.4%	16.0%	21.8%	34.4%
Married RS to Single RO	50.9%	52.4%	56.6%	40.4%
Single RS to Single RO	23.2%	20.6%	11.9%	11.7%
Single RS to Married RO	6.2%	6.1%	4.1%	10.1%
% of Married RO	21.8%	23.9%	44.9%	67.3%
Total Observations	28,408	36,606	23,974	2,665

D. PRELIMINARY DATA ANALYSIS

This section provides a preliminary data analysis before developing multivariate models. In each subsection, one hypothesis is tested by performing a t-test and assessing the difference in means. In addition, the means, standard deviations, and p-values are provided for each variable and the tests. For binary variables, the mean value represents the percentage of observations for which the variable is observed (or has a value of 1). The hypotheses tested are:

Ho : There is no difference in means for both married and unmarried USMC officers

Ha : There is a significant difference in means in favor of married USMC officers

All T-tests performed are between married and single officers and are one-tailed tests.

1. Performance Index (PI)

Table 15 presents average PIs for married and unmarried USMC officers at 5 different grades. Although the panel data format is utilized in the PI model estimations, in order to better analyze the data, we benefited from longitudinal format data for this section. It is quite remarkable that, although the PI mean values are highly inflated and all of them are above 96, there are still some significant differences at O-2 (significant at .10) and at O-5. For 368 officers at O-5, the overall average PI is 99.95; and throughout 5 different ranks, from O-1 to O-5, there is a constant average PI increase. Besides this trend, there is also a significant difference in average PIs among married and unmarried officers in favor of married USMC officers. The T-test revealed a similar result for O-2's but it is only significant at .10 level. However, for O-1, O-3, and O-4 the analysis revealed no significant differences.

Table 15. Average PIs by Marital Status

Marital Status	N	Means (Standard Deviations)
PI for O-1		
Married at Accession	**12323**	**96.63 (4.23)**
Single at Accession	**5238**	**95. 87 (4.64)**
T-Test	**t =10.50 (P < t = 1.000)**	
PI for O-2		
Married at O-1	**10339**	**97.63 (3.64)**
Single at O-1	**8981**	**97.70 (3.24)**
T-Test	**t = -1.39 (P < t = 0.0830)**	
PI for O-3		
Married at O-2	**7219**	**98.66 (2.82)**
Single at O-2	**6542**	**98. 70 (3.11)**
T-Test	**t = -0.74 (P < t = 0.2296)**	
PI for O-4		
Married at O-3	**1531**	**99.49 (1.83)**
Single at O-3	**3263**	**99.55 (1.62)**
T-Test	**t = -1.05 (P < t = 0.14)**	

Table 15. Average PIs by Marital Status (Cont.)

Marital Status	N	Means (Standard Deviations)
PI for O-5		
Married at O-4	42	99.82 (0.78)
Single at O-4	326	99.97 (0.20)
T-Test	t = -2.84 (P < t = 0.0024)	

2. Promotion and Retention

Table 16 has t-test results for three different samples. Sample 1 shows O-4 promotion rates of 17,656 USMC officers by marital status. The promotion rate is .48 for married and .38 for unmarried officers. The T-test showed that this difference is significant. Sample 2 compares O-5 promotion rates of 5,338 USMC officers by marital status. The promotion rate is .25 for married and .21 for unmarried officers. The T-test showed that this difference is significant. Sample 3 provides comparison between 10-year retention rates of 16,170 USMC officers by marital status. The retention rate is .48 for married and .39 for unmarried officers. The T-test showed that this difference is significant.

Table 16. Promotion and Retention Rates by Marital Status

Married O-3	N	Mean (Std. Deviation)	Sample
		Promotion to O-4	1
Single	6,618	0.38 (0.49)	
Married	10,396	0.48 (0.50)	
T-Test	t = -12.20 (P < t = 0.000)		
Married O-4	N	Promotion to O-5	2
Single	747	0.21 (0.41)	
Married	4,591	0.25 (0.45)	
T-Test	t = -2.70 (P < t = 0.0035)		
Married O-3	N	10 YCS Retention	3
Single	5,518	0.39 (0.0066)	
Married	9,704	0.48 (0.0051)	
T-Test”	t =-10.73 (P < t = 0.0000)		

3. Supervisor Favoritism

Although the panel format data is utilized in the supervisor favoritism model estimations, in order to better analyze the data, we benefited from the longitudinal format of the supervisor favoritism dataset in this section. Table 17 presents the T-test statistics

of the mean PI value differences by rank for matches of the marital statuses of RSs and ROs. The tests indicate that average values of PIs where married RSs matches with the married ROs are higher then the average values of PIs where they don't match only for O-1 fitreps. Interestingly, in the other grades, the mean values of the PIs given by married RSs to single ROs are significantly greater than the mean values of the PIs given in other possible matches. Besides, for the first two grades, single supervisors evaluate single officers with higher scores. Thus, our preliminary analysis does not support the favoritism hypothesis.

Table 17. Average PIs by Marital Status Matches Between RSs and ROs

Marital Status Match	N	Means (Standard Deviations)
PI for O-1		
Married to Married	**4,102**	**97.34 (4.46)**
No match	**24,306**	**97.05 (4.69)**
T-Test	**t =-3.73 (P < t = 0.0001)**	
Married to Single	**14,484**	**97.12 (4.65)**
No match	**13,924**	**97.07 (4.66)**
T-Test	**t = -0.863 (P < t = 0.1941)**	
Single to Married	**1,784**	**97.09 (4.63)**
No match	**26,624**	**97.09 (4.66)**
T-Test	**t = 0.035 (P < t = 0.5140)**	
Single to Single	**6,581**	**97.40 (4.10)**
No match	**21,827**	**97 (4.81)**
T-Test	**t = -6.11 (P < t = 0.0001)**	
PI for O-2		
Married to Married	**5,870**	**98.13 (4.28)**
No match	**30,736**	**98.39 (3.73)**
T-Test	**t =4.85 (P < t = 1.000)**	
Married to Single	**19,200**	**98.47 (3.63)**
No match	**17,406**	**98.21 (4.01)**
T-Test	**t = -6.61 (P < t = 0.0000)**	
Single to Married	**2,225**	**98.10 (4.03)**
No match	**34,381**	**98.37 (3.81)**
T-Test	**t = 3.16 (P < t = 0.99)**	
Single to Single	**7,552**	**98.45 (3.56)**
No match	**29,054**	**98.33 (3.89)**
T-Test	**t = -2.42 (P < t = 0.0077)**	

Table 17. Average PIs by Marital Status Matches Between RSs and ROs (Cont.)

PI for O-3		
Married to Married	**5,237**	**99.19 (2.96)**
No match	**18,737**	**99.29 (2.40)**
T-Test	**t =2.42 (P < t = 0.99)**	
Married to Single	**13,569**	**99.41 (2.19)**
No match	**10,405**	**99.07 (2.91)**
T-Test	**t = -10.23 (P < t = 0.0000)**	
Single to Married	**977**	**98.34 (3.99)**
No match	**22,997**	**99.30 (2.44)**
T-Test	**t = 11.71 (P < t = 1.000)**	
Single to Single	**2,847**	**99.98 (2.78)**
No match	**21,127**	**99.30 (2.49)**
T-Test	**t = 6.4 (P < t = 1.000)**	
PI for O-4		
Married to Married	**917**	**99.55 (1.50)**
No match	**1,748**	**99.47 (2.64)**
T-Test	**t =-0.93 (P < t = 0.1775)**	
Married to Single	**1,076**	**99.63 (1.28)**
No match	**1,589**	**99.41 (2.79)**
T-Test	**t = -2.37 (P < t = 0.0088)**	
Single to Married	**270**	**99.88 (5.47)**
No match	**2,395**	**99.57 (1.59)**
T-Test	**t = 4.62 (P < t = 1.000)**	
Single to Single	**312**	**99.49 (1.67)**
No match	**2,353**	**99.50 (2.38)**
T-Test	**t = 0.0945 (P < t = 0.5376)**	

E. SUMMARY

This chapter discusses briefly the USMC personnel and officer promotion system. It also describes the three different data files used in the analysis: the MCCOAC file, the old fitrep data file, and the new fitrep data file. The construction of dependent and focus variables is explained in detail. By defining five different performance models and forming different samples for them at different observation points, we tried to analyze the existence of a marriage and dependency premium. Our preliminary analysis indicates that married officers and officers with additional non-spousal dependents perform better in fitreps and have more promotion and retention rates.

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IV. MODELS

A. INTRODUCTION

In the preliminary analysis, the marriage premium was obtained by estimating the differences in mean values of performance indicators between married and single personnel. This chapter specifies multivariate models that include other covariates to explain the variation in the performance indicators. The model specifications are based on the models used by North and Goldhaber (1995), Hosek et. al. (2001), Ergun (2003), and Kol and Ryu (2002).

In all models, marital- and dependent-related variables are the focus variables. Other explanatory variables are selected from personal, demographic, and job-related characteristics, as well as cognitive capability, experience, and compatibility to military jobs. Each model explanation includes the related hypothesis tested in the model, the specification of the model, and the hypothesized relationship of the included explanatory variables. The model specifications contain both baseline models and selection models.

B. PERFORMANCE INDEX MODELS

1. Hypotheses

Hypothesis 1 will answer the question whether married personnel perform better than single personnel according to performance evaluation outcomes. The first hypothesis of the performance models is that married male Marine officers receive higher performance scores than their single counterparts. Hypothesis 1 is stated below where *m* reperesents the marital status of marine officers.

Hypothesis 1

$Ho : PI_{m=1} = PI_{m=0}$

$H_A : PI_{m=1} > PI_{m=0}$

Hypothesis 2 will test whether the marriage premium is related to the years spent in marriage. This hypothesis is based on human capital investment and household specialization theories which logically require that more years spent in marriage provide

more labor market specialization and/or human capital accumulation and consequently more marriage premium gained. Hypothesis 3 is that each additional year in marriage results in a higher marriage premium for married male officers where *m* represents the marital status of marine officers and *n* represents the number of years spent in marriage.

Hypothesis 2

$Ho : PI_{m=1,n+1} = PI_{m=1,n}$

$H_A : PI_{m=1,n+1} > PI_{m=1,n+1}$

Hypothesis 3 will test if having more non-spousal dependents increases the performance of married male officers. The relationship between dependents and productivity can be hypothesized in two different ways. According to the household specialization theory, more dependents may lead Marine officers to specialize less in labor market activities due to their increase in the household activities. On the contrary, the greater responsibility caused by more dependents may motivate officers to work harder and perform better. Additionally, the magnitude of the effect of dependents may also be related to the marital status. Thus, hypothesis 3 is that having additional non-spousal dependents increases the performance scores of officers. This hypothesis is presented below where *n* is the number of dependents that an officer has when he received the performance evaluation.

Hypothesis 3

$Ho : PI_{n+1} = PI_{n}$

$H_A : PI_{n+1} > PI_{n+1}$

Hypothesis 4 will address the question whether the marriage premium is uniquely related to marriage. To test this hypothesis, the performances of married officers, officers who are not married but who will marry in the future grades (to-be-married), and officers who are not married and who will not marry in the future grades (to-be-single) will be compared. If "to-be-married" officers' performance is not different from "to-be-single" officers' performance, the selectivity hypothesis which states that the marriage premium is due to better-performing officers' selection into marriage will be rejected. The fourth hypothesis is that married officers' performance is higher than "to-be-married" officers'

performance, whose performance is not different from "to-be-single" officers'. This hypothesis is presented below where *s* represents the current or the future marital status of the officer.

Hypothesis 4

Ho : $PI_{s=married} = PI_{s=to\text{-}be\text{-}married} = PI_{s=to\text{-}be\text{-}single}$

H_A : $PI_{s=married} \neq PI_{s=to\text{-}be\text{-}married} = PI_{s=to\text{-}be\text{-}single}$

2. Model Specification

a. POLS Model Specification

There are four identical model specifications for hypotheses in which only the focus variables differ. The first model is to estimate the marriage premium in PI by controlling marital/dependent-related variables, demographics, commissioning age, commissioning fiscal years, job-related characteristics, cognitive ability, commissioning sources and job experience.

Table 18. OLS Multivariate Regression Model Specifications for PI

PI = β_0 + β_1 (Marital Status/ Married vs. To-be-married/ Accumulated Married Years / Number of Dependents) + other control variables.

where other control variables are commissioning age, ethnicity group, gct score, tbs overall class rank percentile, commissioning source, and commissioning fiscal years.

b. FE Model Specification

The fixed-effects technique is widely used in the literature on the marriage premium to test selectivity into marriage by eliminating the effects of unobservable, individual-specific factors that correlate with high wages and cause a bias in the marriage dummy coefficient. The fixed effects model simply takes the difference between each value in different observations and the average of those values over time for each individual. The original model is presented below where a_i = unobservable heterogeneity.

$$PI_{it} = \beta_0 + \beta_1 X_{it} + a_i - u_{it}, t = 1,2,3,4,5$$

The transformation of the fixed effects technique is presented below where the dependent variable is the time-demeaned data on PI. X_{it} represents both observable and unobservable characteristics in the t^{th} time point for the i^{th} officer.

$$\left(PI_{it} - \overline{PI}_i\right) = \beta_1\left(X_{it} - \overline{X}_i\right) + u_{it}, t = 1,2,3,4,5$$

The model specifications for the fixed-effect are presented below:

Table 19. Fixed-Effects Model Specifications for PI

$\left(PI_{it} - \overline{PI}_i\right)$ = β_1(Marital Status/ Married vs. To-be-married/ Accumulated Married Years / Number of Dependents)$_{it}$ — Average(Marital Status/ Married vs. To-be-married/ Accumulated Married Years / Number of Dependents)$_i$] + other control variables

Other control variables are commissioning age, ethnicity group, gct score,, tbs overall class rank percentile, commissioning source, commissioning fiscal year.

c. Heckman Model Specification

While testing the first four hypotheses on PI for O-4 and O-5, we used the Heckman procedure. Since there is a potential bias in some coefficients due to the retention decision, there is a need to control for selection bias. In other words, because of the officers who leave, the sample may not be a representative sample of all officers. In one case, the officers who left before O-4 may be the better ones who have better civilian job prospects. The officers who stay are lower performers. This will create a downward bias. However, on the other hand, the officers who leave before O-4 may be lower performers who believe that they have less of a promotion chance. In this case, the sample will be filled with good officers and thus will create an upward bias.

The Heckman procedure obtains an "Inverse Mills Ratio" for each observation in the survival sample. The 'Inverse Mills Ratio' represents the probability that an officer survives to the promotion board of the given grade. The procedure requires that the first-stage survival equation include at least one instrumental variable that is related to retention, but not related to the performance index. As Table 20 shows, MOS groups and prior enlisted service are used as instrumental variables in the survival equations and excluded from the second-stage PI models.

Different MOS groups are used as instrumental variables because there is a connection between MOS and retention. One particular MOS group may have better job opportunities in civilian life then others, and this difference affects the retention decision. However, there is not so much relationship between MOS groups and the PIs received, which supports omitting these variables from the PI model.

Being priorly enlisted is another instrumental variable and is an indicator of taste for the military. Being priorly enlisted may result from receiving better PIs in early periods. Therefore, we can assume that, generally, being priorly enlisted is not related to receiving better PIs. On the other hand, it is a factor for retention. It is an indicator of taste and priorly enlisted officers may establish stronger ties to the military than non-priorly enlisted officers.

Table 20. Heckman Model Specifications for PI

Selection Equation

1. $P(s_i=1|z) = \Phi(\gamma_1, \text{MOS groups} + \gamma_2, \text{Prior Enlisted Service} + \text{other factors})$, i=4,5

Regression Equation

2. $PI(O_i) = \beta_0 + \beta_1(\text{Marital Status/ Married vs. To-be-married/ Accumulated Married Years / Number of Dependents}) + \text{other factors}$, i=4,5

In the model specification above, *i* is the grade of the officer and other factors are commissioning age, ethnicity group, TBS overall class rank percentile, commissioning source, commissioning fiscal year.

3. Hypothesized Effects of the Explanatory Variables

Table 21 lists the explanatory variables and their hypothesized relationship to PI. Of the focus variables, being married, additional years in marriage, and having dependents are expected to be positively related to the PI, while to-be-married is supposed to be no different than to-be-single, which are both negative when compared to currently married officers. The first recorded GCT scores of the Marine officers are used as a proxy of their cognitive ability and are expected to be positively related to the PI. Although there is no reported discrimination based on ethnicity in USMC performance

evaluation, African Americans, Hispanics, and Other Race groups are expected to receive lower performance scores relative to White officers. The commissioning fiscal year is expected to be positive since it is used to capture the score inflation over time.

The Basic School (TBS) overall class-rank percentile is used as a proxy for job-related characteristics. This variable is the average of TBS leadership and the academic and military class-rank percentiles. Quester and Hiatt (2001) use the TBS class ranks as a proxy for the officer's quality. North and Goldhaber (1995) state that, regardless of the measure, the TBS leadership class percentile is associated with higher success rates. Ergun also estimates similar results with the TBS overall class-rank percentile. Thus, it is expected that this variable is positively related to the PI. Ergun also finds that ECP, MCP, PLC, and OCC commissioning sources have a negative effect on PI relative to USNA.

Table 21. Hypothesized Effects of the Explanatory Variables on PI

Variable Group	Variable Name	Variable Description	Expected Sign
Hypothesis 1	Married Divorced	Married at previous rank Divorced at previous rank	+ (compared to not married)
Hypothesis 2	Accmaryear	Additional Marriage Years	+
Hypothesis 3	Numkidsprev	Number of Dependents at the previous rank	+
Hypothesis 4	Marr_curr	Currently Married	+
	To-be-married	Currently not married but will marry in the future	?
	To-be-single	Currently not married and will not marry in the future	(base marital status)
Personal Characteristics	Comm. age	Commissioning age	+
	White	White	(base ethnicity group)
	Africaname	African American	-
	Hispanic	Hispanic	-
	Otherrace	Other Race	-
Job-related characteristics	Tbsperc	TBS Overall Class Rank Percentile	+
Cognitive ability	f_gct	First recorded GCT score	+
Commissioning sources	Usna	USNA	(base comm. source)
	Nrotc	NROTC	+
	Pl	PLC	-
	Occ	OCC	-
	Mecep	MECEP	+
	Ecp	ECP	-
	Mcp	MCP	-
Commissioning Fiscal Year	FY_80 – FY_99	Commissioning Fiscal Year	+

C. SUPERVISOR FAVORITISM MODEL

1. Hypothesis

Hypothesis 5 will answer the question whether married supervisors give higher performance evaluations to married officers than to single officers. In order to test this hypothesis, the marital status of supervisors and their subordinates are matched. If married officers are found to receive higher fitreps from married supervisors rather than single supervisors, or if single officers are found to receive lower fitreps from married supervisors as compared to single supervisors, the potential marriage premium will be upward biased due to supervisor favoritism. This hypothesis is presented below where *sm* is the marital status of the supervisor and *om* is the marital status of the recorded officer.

Hypothesis 5

$$Ho : PI_{sm=1,\ om=1} = PI_{sm=1,\ om=0}$$

$$H_A : PI_{sm=1,\ om=1} > PI_{sm=1,\ om=0}$$

2. Model Specifications

a. POLS Model Specification

Two successive model specifications are implemented. The first model specification has the same control variables in the PI models. Performance evaluations that are given by married supervisors to married officers, by married supervisors to single officers, and by single supervisors to single officers are compared according to their association with performance evaluations that are given by single supervisors to married officers. In the second model specification, recorded officers' physical fitness (pft), rifle, and pistol scores are included to test whether the coefficients of focus variables stay stable. A match of single supervisors and married officers is used as the base case. Table 22 presents these two model specifications. Other control variables are commissioning age, ethnicity group, tbs overall class rank percentile, commissioning source, commissioning fiscal year.

Table 22. POLS model specifications for Supervisor Favoritism

1. $PI = \beta_0 + \beta_1$ (Married_to_Married) + β_2 (Married_to_Single) + β_3 (Single_to_Single) + other control variables
2. $PI = \beta_0 + \beta_1$ (Married_to_Married) + β_2 (Married_to_Single) + β_3 (Single_to_Single) + β_4 (**pft score) +** β_5 (**rifle score) +** β_6 (**pistol score**) + other control variables

b. FE Model Specification

For the FE estimations, the second model specification of the POLS models is utilized. In this model, besides the focus variables, pft,, rifle, and pistol scores also change over time. These scores are physical measures that are measured objectively. Therefore, the effect of supervisor favoritism is better captured by using additional time-variant performance measures, which are immune to any bias related to supervisors. The model specification is presented below:

Table 23. Fixed-Effects Model Specifications for Supervisor Favoritism

$$\left(PI_{it} - \overline{PI}_i\right) = \beta_1(\text{Married\_to\_Married}_{it} - \text{Married\_to\_Married}_i) + \beta_2(\text{Married\_to\_Single}_{it} - \text{Married\_to\_Single}_i) + \beta_3(\text{Single\_to\_Single}_{it} - \text{Single\_to\_Single}_i) + \beta_4(\textbf{pft score}_{it} - \textbf{pft score}_i) + \beta_5(\textbf{rifle score}_{it} - \textbf{rifle score}_i) + \beta_6(\textbf{pistol score}_{it} - \textbf{pistol score}_i) + \text{other control variables}$$

Other control variables are commissioning age, ethnicity group, tbs overall class rank percentile, commissioning source, commissioning fiscal years.

3. Hypothesized Effects of the Explanatory Variables

The expected magnitude and amount of the effects of matches of marital status of supervisors and recorded officers is unclear. Other controlled variables have the same hypothesized effects as mentioned in the PI model specification section.

Table 24. Hypothesized Effects of the Explanatory Variables on PI

Variable Group	Variable Name	Variable Description	Expected Sign
Hypothesis 5	Married2Married Married2Single Single2Married Single2Single	Matches of marital statuses of supervisors and recorded seniors	? ? ? ?
Personal Characteristics	Comm. age	Commissioning age	+
	White	White	(base ethnicity group)
	Africaname	African American	-
	Hispanic	Hispanic	-
	Otherrace	Other Race	-
Job-related characteristics	Tbsperc	TBS Overall Class Rank Percentile	+
Commissioning sources	Usna	USNA	(base comm. source)
	Nrotc	NROTC	+
	Plc	PLC	-
	Occ	OCC	-
	Mecep	MECEP	+
	Ecp	ECP	-
	Mcp	MCP	-
Commissioning Fiscal Year	FY_80 – FY_99	Commissioning Fiscal Year	+

D. PROMOTION MODELS

1. Hypotheses

Hypothesis 6 will answer the question whether there is a premium in the probability to promote in the most competitive promotion boards for married personnel. This hypothesis is that married male Marine officers are more likely to promote to the fourth and fifth grades. Hypothesis 6 is stated below where m represents the marital status of the officers.

Hypothesis 6

$Ho : Prom_{m=1} = Prom_{m=0}$

$H_A : Prom_{m=1} > Prom_{m=0}$

Hypothesis 7 will test the question whether more accumulated years in marriage increase the probability to promote for married men. This hypothesis is based on the same suggestions as Hypothesis 2. Hypothesis 7 is that each additional year spent in marriage increases the probability to promote to the fourth and fifth grades. Hypothesis 7 is stated below where m represents the marital status of marine officers and n represents the number of years spent in marriage.

Hypothesis 7

$Ho: Prom_{m=1,n+1} = Prom_{m=1,n}$

$H_A: Prom_{m=1,n+1} > Prom_{m=1,n}$

Hypothesis 8 will test the effect of having non-spousal dependents on the probability to promote. Again the same suggestions as for Hypothesis 3 are used to establish this hypothesis. Hypothesis 8 is that having additional non-spousal dependents increases the probability to promote. Hypothesis 8 is stated below where n is the number of dependents that an officer has when he received the performance evaluation.

Hypothesis 8

$Ho : Prom_{n+1} = Prom_{n}$

$H_A : Prom_{n+1} > Prom_{n}$

Hypothesis 9 will address the question whether the promotion rates of married officers are different from those of officers who are not married but who will marry in the

future grades (to-be-married). The ninth hypothesis is that married officers' promotion probability is higher than "to-be-married" officers' promotion probability, whose promotion probability is not different from "to-be-single" officers'. This hypothesis is presented below where s represents the current or the future marital status of the officer.

Hypothesis 9

$Ho : Prom_{s=married} = Prom_{s=to\text{-}be\text{-}married} = Prom_{s=to\text{-}be\text{-}single}$

$H_A : Prom_{s=married} > Prom_{s=to\text{-}be\text{-}married} = Prom_{s=to\text{-}be\text{-}single}$

2. Model Specification

The promotion models use simple probit estimation. As discussed in the data chapter, promotions to the fourth and fifth grades are the most competitive selection processes in Marine officers' career. Promotion models use specifications similar to the Performance Index models.

Table 25. Probit Model Specifications for Promotion to O-4 and O-5.

Prom $(O_i) = \beta_0 + \beta_1$ (Marital Status / Accumulated Married Years / Number of Dependents / Married vs. To-be-married) + other factors , i= 4,5

Other factors are ethnicity group, tbs overall class rank percentile , commissioning source.

Due to the selection bias resulting from retention decisions, we benefited from a maximum likelihood probit estimation (MLPE) with sample selection. By doing so, we tried to control for the existing selection bias. Similar to the case for the PI samples, officers who made O-3 or O-4 but did not stay until the O-4 or O-5 promotion board made the sample a heterogeneous one that may create selection bias. Commissioning age, prior enlisted service, MOS groups, receiving recommendation for accelerated promotion and recommendation for no promotion, are included as instrumental variables that are correlated with survival but not with promotion. Table 26 exhibits model specifications for a maximum likelihood probit estimation with selection techniques.

Differing from Heckman estimation model specifications, commissioning age is kept in the selection equation as an instrumental variable but is not included in the regression equation, since commissioning age is not a factor in promotion to O-4 or O-5

but is a factor in retention. Older commissioned officers may not want to leave the military and build a career in civilian life because of their age. On the other side, younger commissioned officers may prefer to leave early to build a career outside the military.

Different MOS groups are also used as instrumental variables because there is a connection between MOS and retention. One particular MOS group may have better job opportunities in civilian life then others and this difference affects the retention decision. However, MOS should not affect promotion.

Being "prior enlisted" is another instrumental variable and an indicator of taste for the military. Being prior enlisted may result in receiving better PIs in early periods, but then there will be no effect because the gap between prior enlisted and non-enlisted officers disappears. Therefore, we can accept that, generally, being prior enlisted is not related to receiving better PIs. On the other hand, it is a factor for retention. It is an indicator of taste and prior enlisted officers may establish stronger ties to the military than non prior enlisted officers.

Table 26. Maximum Likelihood Probit Estimation with Selection Model Specifications for Promotion to O-4 and O-5

Selection Equation

1. $P(s_i=1|z) = \Phi(\gamma_1$, MOS groups + γ_2, Prior Enlisted Service + γ_3, Commissioning age + γ_4, Recommendation for accelerated promotion + γ_5, Recommendation for no promotion + other factors) , i=4,5

Regression Equation

2. Prom $(O_i) = \beta_0 + \beta_1$(Marital Status/ Married vs. To-be-married/ Accumulated Married Years / Number of Dependents) + other factors , i=4,5

Table 27 lists the explanatory variables and their hypothesized relationship to promotion outcomes. Different from the PI models, the effect of minority status on promotion probability is not clear. Similar to the PI models, the TBS class-rank percentile is expected to be positive. Quester and Hiatt (2001) state that "there is a very strong relationship between TBS rank and the probability of promotion to major, with those in the top third of their TBS classes having almost doubled the probability of promotion to

major of those in the bottom third." Enlisted commissioning programs that are related to prior enlisted officers are expected to affect the promotion probability positively for the fourth grade and negatively for O-5. North and Goldhaber (1995) hypothesize that since prior enlisted officers become eligible for retirement when they are up for the fifth grade promotion, promotion board members may be unwilling to take a chance on an officer who may retire after promotion. They also point out that eligibility for retirement may also affect prior enlisted officers' motivation to work harder. From the literature, we expect that marital status at the promotion board, accumulated years in marriage, and the number of non-spousal dependents has a positive effect on both promotion outcomes.

Table 27. Hypothesized Effects of the Explanatory Variables on PI.

Variable Group	Variable Name	Variable Description	Expected Sign	
			O-4	O-5
Hypothesis 6	Married_O3 Married_O4	Married (at O-3, O-4)	+	+
Hypothesis 7	accmaryears	Additional Marriage Years	+	+
Hypothesis 8	numkidsprev	Number of Dependents at the previous rank	+	+
Hypothesis 9	Marr_curr	Currently Married	+	
	To-be-married	Currently not married but will marry in the future	?	
	To-be-single	Currently not married and will not marry in the future	(base marital status)	
Ethnic Characteristics	white	White	(base ethnicity group)	
	africaname	African American	?	?
	hispanic	Hispanic	?	?
	otherrace	Other Race	?	?
Job-related characteristics	tbsperc	TBS Overall Class Rank Percentile	+	+
Commissioning sources	usna	USNA	(base commissioning source)	
	nrotc	NROTC	?	?
	plc	PLC	?	?
	occ	OCC	?	?
	mecep	MECEP	+	-
	ecp	ECP	+	-
	mcp	MCP	+	-

E. RETENTION MODELS

1. Hypotheses

Hypothesis 10 will answer the question whether married marine officers are more likely than their single counterparts to retain 10 years in service. This hypothesis is that male marine officers who are married at accession are more likely to retain ten years in

service than those who are not married at accession. Hypothesis 8 is stated below where *m* represents the marital status of officers.

Hypothesis 10

$Ho : Retention_{m=1} = Retention_{m=0}$

$H_A : Retention_{m=1} > Retention_{m=0}$

Hypothesis 11 will test the effect of having non-spousal dependents on the retention decision of Marine officers. The suggestion in this hypothesis is that having dependents other than a spouse increases the financial responsibility of marine officers and causes them to stay in the military. Thus, Hypothesis 11 is that having additional non-spousal dependents increases the probability to retain 10 years in service. Hypothesis 11 is stated below:

Hypothesis 11

$Ho : Retention_{n+1} = Retention_{n}$

$H_A : Retention_{n+1} > Retention_{n}$

Hypothesis 12 will focus on the question whether the retention rates of married officers are different from those of officers who are not married but will marry in future grades (to-be-married). This hypothesis is that married officers' retention probability is higher than "to-be-married" officers', whose retention probability is not different from "to-be-single" officers'. This hypothesis is presented below where s represents the current and future marital status of the officers.

Hypothesis 12

$Ho : Ret_{s=married} = Ret_{s=to\text{-}be\text{-}married} = Ret_{s=to\text{-}be\text{-}single}$

$H_A : Ret_{s=married} > Ret_{s=to\text{-}be\text{-}married} = Ret_{s=to\text{-}be\text{-}single}$

2. Model Specification

The model specification for the retention estimates are based on the model used by Ergun (2002). The specification of the models according to three hypotheses is presented in Table 28. In the second model, besides job-related characteristics, commissioning sources, and job experience, PI in the first rank is also included to control for the Marine officer's future success anticipation.

Table 28. Simple Probit Regression Model Specifications for Retention Models

Retained_10YCS = $\beta_0 + \beta_1$ (Marital Status at accession / Number of Dependents at accession/ Married vs. To-be-married at accession) + other factors

Other factors are commissioning age, ethnicity group, gct score, tbs overall class rank percentile, prior enlisted service, commissioning source, and mos groups.

3. Hypothesized Effects of the Explanatory Variables

Table 29 lists the explanatory variables and their hypothesized relationship to retention probability. Marital status at accession is expected to be positively related to retention. Prior enlistment status and enlisted commissioning programs are also expected to retain more, since enlistment background is also a sign of having a taste for military service. Under the assumption that shorter pre-commissioning military training leads to a lower taste for the military, Ergun (2002) estimates the negative effects of being PLC and OCC graduates on the retention decision. Since Hosek et. al (2001) find that black men are more likely to stay in the military voluntarily, the signs for being African American is expected to be positive relative to the base group, being white. However, the sign for other ethnic groups are unclear. TBS percentile is expected to be positive.

Table 29. Hypothesized Effects of the Explanatory Variables on 10 Year Retention

Variable Group	Variable Name	Variable Description	Expected Sign
Hypothesis 10	Married_acc	Married at accession	+ (compared to not married)
Hypothesis 11	numkidsprev	Number of Dependents at accession	+
Hypothesis 12	Marr_curr	Currently Married	+
	To-be-married	Currently not married but will marry in the future	?
	To-be-single	Currently not married and will not marry in the future	(base marital status)
Personal Characteristics	Comm._age	Commissioning age	+
	White	White	(base ethnicity group)
	africaname	African American	+
	hispanic	Hispanic	?
	otherrace	Other Race	?
Job-experience	priorenl	Prior Enlisted Service	+
Job-related characteristics	tbsperc	TBS Overall Class Rank Percentile	+
Cognitive ability	f_gct	First recorded GCT score	?
Commissioning sources	Usna	USNA	(base comm. source)
	Nrotc	NROTC	?
	Plc	PLC	-
	Occ	OCC	-
	mecep	MECEP	+
	Ecp	ECP	+
	Mcp	MCP	+

F. CHAPTER SUMMARY

This chapter describes the model specifications according to three different performance indicators. PI models use OLS and FE regressions to analyze the marriage premium in PI scores. Both promotion and retention models use simple probit estimations. For the O-4 and O-5 PI estimations, the Heckman procedure is used, and for the promotion to O-4 and O-5 estimations, the maximum likelihood probit estimation (MLPE) with selection is used in order to have better coefficients that are corrected against possible effects of an expected selection bias emerging from the U.S. Marine Corps officers' retention decision. The model specifications are based on the prior literature and the availability of the variables in the dataset. All models include marital status, accumulated years in marriage, number of non-spousal dependents, and to-be-married status as the focus variables, except the retention model in which accumulated years in marriage is not available to estimate.

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V. RESULTS

This chapter contains results for each of the performance measures according to the appropriate modeling techniques. The results are presented in four main sections. The first section focuses on the marriage and dependency differentials in the performance indexes. In the second section, analyses of the effect of supervisor favoritism on performance evaluation are tested by looking at matches of the marital statuses of supervisors and their subordinates. The third section analyzes the premium of these focus variables on promotion probabilities to O-4 and O-5. Finally, the last section presents analyses of the effect of marital status and the number of non-spousal dependents on the 10-year retention decisions of male marine officers. Each section begins with descriptive statistics of the sample used and continues with a presentation of the regression results. Besides the Panel OLS technique, PI models are estimated by fixed-effects to see if the premium is affected by unobservable individual characteristics. Since there is an expected selection bias that is supposed to emerge from the retention decisions of U.S. Marine Corps officers prior to O-4 and O-5, the models that are related to these ranks are also estimated by controlling for selectivity. PI estimations for O-4 and O-5, which have continuous dependent variables, are estimated by using the Heckman procedure. On the other hand, for the promotion models, which have dichotomous dependent variables, maximum likelihood probit estimators (MLPE) with selection technique is applied.

A. PERFORMANCE INDEX MODEL ESTIMATES

1. Descriptive Statistics

Sample means of the controlled variables according to the dichotomous focus variables in estimations are shown in the first four columns of Table 30. The last two columns consist of the correlations between continuous focus variables and other controlled variables in the models. Married officers are approximately 1 year older than single officers. White officers are the most dominant race group in the USMC officer corps, occupying 90 percent of the sample. Interestingly, divorced officers have the highest TBS class rank percentile, 57.3, in average. Married and "to-be-married" officers follow divorced officers by 54.6 and 53.4 percentage points, respectively. Among the six commissioning sources, with a 40 percentage of the sample observations, PLC graduates

have the highest representation. In addition, MECEP and ECP graduates are more correlated with the number of children than other commissioning programs' graduates.

Table 30. Sample Means of the Variables in PI Model

Variables	Married	Single	Divorced	To be Married	Number of Non-spousal Dependents	Accumulated Marriage Years
Commissioning Age	23.579	22.833	24.259	22.821	0.167	0.124
White	0.897	0.882	0.901	0.889	0.010	0.030
African American	0.049	0.052	0.045	0.046	0.006	-0.007
Hispanic	0.032	0.034	0.037	0.033	-0.005	-0.012
Other Race	0.022	0.033	0.017	0.031	-0.022	-0.035
TBS Class Percentile	54.675	50.248	57.337	53.400	0.082	0.080
GCT Score	128.659	128.302	128.844	128.680	0.033	0.018
Commissioning Source-USNA	0.093	0.130	0.058	0.141	-0.031	-0.046
Commissioning Source-NROTC	0.170	0.223	0.157	0.232	-0.049	-0.049
Commissioning Source-PLC	0.399	0.425	0.326	0.420	-0.065	-0.032
Commissioning Source-OCC	0.218	0.193	0.211	0.173	0.025	0.042
Commissioning Source-MECEP	0.062	0.008	0.157	0.013	0.172	0.086
Commissioning Source-ECP	0.058	0.020	0.091	0.021	0.108	0.089

2. Panel OLS (POLS) Estimates

Table 31 presents coefficients, standard errors, and p-values from the POLS regressions on PI. OLS estimates for each rank are presented in Appendix A. Each model specification differs only in the focus variables in order to analyze the related hypothesis. The models explain 15-20 percent of the variation in the PI.

Model 1 analyzes the PI premium related to the marital status. POLS regression results indicate that married officers receive a 0.7-point higher performance evaluation than single male marine officers. This result is significant at the 1-percent level. Although divorced officers were expected to receive a positive premium, their premium is higher

than that of married officers. This finding is consistent with the human capital accumulation hypothesis, which states that divorced officers may accumulate more human capital while they were married and thus they may perform better than officers who have not been married.

Model 2 analyzes whether marriage has a dynamic productivity enhancing effect as in Kenny (1983), Korenmark and Neumark (1991), and Mehay and Bowman (2004). Estimates indicate that each additional year of marriage increases the performance evaluation grade by .35 points. This result supports both the household specialization and the human capital investment hypotheses. Officers who have spent more years in marriage are able to specialize more in military activities and may have more time or opportunity to invest in human capitals than their counterparts who have spent less time in marriage.

Model 3 focuses on the effect of non-spousal dependents on PI. The model specification includes dummy marital status variables, the number of non-spousal dependents, and interactions of these focus variables. The result of the POLS regression shows that an officer's PI increases as the number of his dependents increases. Each additional non-spousal dependent increases the performance evaluation score by approximately 1 point. Hill (1979) and Mehay and Bowman (2004) report similar results. Hill claims that having non-spousal dependents increases the responsibility of workers, which motivates them to earn more by increasing their productivity. However, interaction variables are negative. The effect of additional non-spousal dependents for married officers diminishes to 0.6 points for married officers and 0.4 points for divorced officers. Anderson and Krieg (2000) state that more dependents may cause married and divorced workers to spend more time doing household work and to specialize less in market work. Although this seems to explain the diminishing effect of additional children for married and divorced officers, it does not explain the higher effects of dependents for single officers. In all cases, non-spousal dependents have a significantly positive effect on PI.

Model 4 focuses on the difference between married and "to-be-married" officers. "To-be-married" officers are single officers who will marry in the future. "To-be-single" officers are the baseline. As discussed in the models section, the analysis of the difference

between married and "to-be-married" officers helps to examine whether the marriage premium is due to unobservable characteristics of the officers that are correlated with both more successful performers and selection into marriage. In other words, it analyzes whether the marriage premium is uniquely related to marriage as Stratton (2002) claims. After separating single officers who are single and will stay single in the future from single officers who will marry in the future, the marriage premium for currently married officers increases by 1 points. This difference is significant at the 1% significance level. The premium for being a "to-be-married" officer is 0.8 points. The close results between married and "to-be-married" officers support the hypothesis that a substantial portion of the marriage premium can be explained by selectivity into marriage.

The magnitude and the effect of control variables other than the focus variables are the same in all the models. Being non-white has a negative impact on the PI. Although GCT scores, which were used as a proxy for cognitive ability, were expected to have positive signs, the results show that officers with high GCT scores receive lower performance evaluation scores. The TBS overall class rank percentile has a positive sign. Similar to Ergun's (2003) results, all commissioning sources have a negative effect on the PI when they are compared to USNA.

Table 31. POLS Estimates of PI Models

	Model-1	Model-2	Model-3	Model-4
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married	0.716	N/A	0.488	1.056
	(20.41)***	N/A	(12.96)***	(23.76)***
Divorced	1.049	N/A	0.998	N/A
	(6.27)***	N/A	(4.65)***	N/A
To be married	N/A	N/A	N/A	0.832
	N/A	N/A	N/A	(19.95)***
Accumulated Marriage Years	N/A	0.351	N/A	N/A
	N/A	(65.33)***	N/A	N/A
Number of Non-Spousal Dependents	N/A	N/A	0.954	N/A
	N/A	N/A	(20.72)***	N/A
Married and have kids	N/A	N/A	-0.355	N/A
	N/A	N/A	(6.93)***	N/A
Divorced and have kids	N/A	N/A	-0.550	N/A
	N/A	N/A	(3.59)***	N/A
Commissioning Age	-0.072	-0.084	-0.094	-0.069
	(6.40)***	(7.70)***	(8.34)***	(6.21)***

Table 31. POLS Estimates of PI Models(Cont.)

	Model-1	Model-2	Model-3	Model-4
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
African American	-0.527	-0.593	-0.549	-0.627
	(5.13)***	(5.48)***	(5.35)***	(5.75)***
Hispanic	-0.171	-0.163	-0.201	-0.181
	(1.78)*	(1.69)*	(2.11)**	(1.87)*
Other Race	-0.233	-0.232	-0.243	-0.232
	(2.30)**	(2.28)**	(2.42)**	(2.31)**
GCT Score	-0.019	-0.018	-0.018	-0.019
	(9.40)***	(9.34)***	(9.23)***	(9.70)***
TBS Class Percentile	0.033	0.033	0.032	0.033
	(45.95)***	(46.50)***	(45.04)***	(47.15)***
Commissioning Source-NROTC	-0.190	-0.244	-0.199	-0.197
	(3.22)***	(4.08)***	(3.37)***	(3.31)***
Commissioning Source-PLC	-0.386	-0.424	-0.384	-0.346
	(6.56)***	(7.28)***	(6.53)***	(5.95)***
Commissioning Source-OCC	-0.142	-0.226	-0.133	-0.129
	(2.09)**	(3.41)***	(1.96)**	(1.93)*
Commissioning Source-MECEP	-0.336	-0.298	-0.608	-0.238
	(3.54)***	(3.20)***	(6.16)***	(2.47)**
Commissioning Source-ECP	-0.374	-0.451	-0.483	-0.337
	(3.41)***	(3.96)***	(4.42)***	(2.90)***
Commissioning Fiscal Year	YES	YES	YES	YES
Constant	98.506	98.076	98.513	97.713
	(252.54)***	(261.40)***	(253.08)***	(257.76)***
Observations	46861	51935	46671	52255
F-stat	253.79	91.22	256.06	355.34
R-squared	0.15	0.20	0.17	0.17
Note 1: Robust t statistics in parntheses				
Note 2: * signifiant at 10%; ** significant at 5%; *** significant at 1%				

Table 32 presents the fixed-effects estimation results of the same models shown in Table 31 and tests the same hypotheses. This method is widely used in the literature on the marriage premium to test selectivity into marriage by eliminating the effects of unobservable, individual-specific factors that correlate with high wages and cause a bias in the marriage dummy coefficient.

Interestingly, FE estimates of PI models yield higher coefficients for all the focus variables. For the first model, the coefficients double. Apparently, observed and

unobserved individual characteristics that are omitted from the POLS estimations cause a downward bias in Table 31. The effect of accumulated years in marriage remains approximately the same with the POLS results. In the third model, the number of non-spousal dependents is found to have a higher impact on PI in the FE estimates. In the fourth model, the effect of being a "to-be-married" officer increase from 0.8 points to 1 point, and the effect of being married decreases by 21 percent to 0.8 points after the effect of individual-specific characteristics are eliminated. This result reinforces the claim that the marriage premium is explained in fact by selectivity into marriage. Different from POLS results, marital status variables have higher coefficients, and interaction terms have lower negative impacts. Thus, married and divorced officers with dependents receive higher performance evaluations than their single counterparts who have the same number of dependents.

Table 32. FE Estimates of PI Models

	Model-1	Model-2	Model-3	Model-4
Variables	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married	1.478	N/A	1.245	0.789
	(25.40)***	N/A	(21.08)***	(21.16)***
Divorced	2.237	N/A	1.810	N/A
	(8.71)***	N/A	(5.85)***	N/A
To be married	N/A	N/A	N/A	1.039
	N/A	N/A	N/A	(24.45)***
Accumulated Marriage Years	N/A	0.364	N/A	N/A
	N/A	(50.29)***	N/A	N/A
Number of Non-spousal Dependents	N/A	N/A	1.201	N/A
	N/A	N/A	(18.61)***	N/A
Married and have kids	N/A	N/A	-0.159	N/A
	N/A	N/A	(2.29)**	N/A
Divorced and have kids	N/A	N/A	-0.0/85	N/A
	N/A	N/A	(0.32)	N/A
Constant	97.231	97.155	96.991	97.048
	(3445.26)***	(5920.02)***	(3330.60)***	(3395.94)***
Observations	46861	51935	46671	54033
Number of ssn1	19626	19932	19604	19625
F-stat	355.14	565.97	316.42	344.38
R-squared	0.02	0.07	0.06	0.01
Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

3. Heckman Estimates

Table 33 presents the results of the Heckman procedure for the PI O-4 outcomes. In these estimates, the longitudinal form of the panel data is used. In all of the four model specifications, inverse mills ratios (λ) are significant, which indicates that there is a sample selection problem due to people leaving prior to the O-4 promotion board. PI OLS estimates for O-4 with the Heckman procedure help to reduce this sample selection bias. The first model tests the first hypothesis, controlling for selection bias which diminishes the marriage premium to 0.1 points for grade O-4. The premium for being divorced turns out to be insignificant. Similarly, the premium for each additional year in marriage decreases to .005 points. The estimate is insignificant. Also, the effect of having an additional dependent is diminished in selection-corrected results. On the other hand, approximately half of the premium for married and for 80-percent of the "to-be-married" officers, according to their association with "to-be-single" officers, remains significant. After controlling for sample selection in the fourth hypothesis, although all marital status and interaction terms are insignificant, the number of dependents still has a significant positive effect on PI as on O-4.

Table 33. Heckman Estimates of PI Models for O-4

	Model-1	Model-2	Model-3	Model-4
Variables	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married at O-3	0.103	N/A	0.064	0.416
	(1.87)*	N/A	(0.99)	(6.39)***
Divorced at O-3	0.035	N/A	0.004	N/A
	(0.17)	N/A	(0.01)	N/A
To be married at O-4	N/A	N/A	N/A	0.646
	N/A	N/A	N/A	(7.73)***
Accumulated Marriage Years at O-4	N/A	0.005	N/A	N/A
	N/A	(0.84)	N/A	N/A
Number of Non-Spousal Dependents at O-4	N/A	N/A	0.172	N/A
	N/A	N/A	(3.16)***	N/A
Married and have kids at O-4	N/A	N/A	-0.071	N/A
	N/A	N/A	(1.17)	N/A
Divorced and have kids at O-4	N/A	N/A	-0.017	N/A
	N/A	N/A	(0.07)	N/A
Commissioning Age	-0.056	-0.053	-0.062	-0.055
	(3.21)***	(3.04)***	(3.56)***	(3.20)***
African American	-0.142	-0.077	-0.132	-0.082
	(1.02)	(0.55)	(0.95)	(0.59)

Table 33. Heckman Estimates of PI Models for O-4 (Cont.)

	Model-1	Model-2	Model-3	Model-4
Variables	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Hispanic	0.305	0.385	0.280	0.383
	(1.61)	(2.00)**	(1.47)	(2.00)**
Other Race	0.206	0.034	0.206	0.050
	(1.08)	(0.19)	(1.08)	(0.27)
TBS Class Percentile	0.003	0.002	0.002	0.001
	(1.71)*	(1.11)	(1.43)	(0.76)
Commissioning Source-ROTC	-0.122	-0.137	-0.112	-0.118
	(1.25)	(1.39)	(1.15)	(1.20)
Commissioning Source-PLC	-0.084	-0.120	-0.067	-0.059
	(0.96)	(1.36)	(0.77)	(0.66)
Commissioning Source-OCC	0.092	0.023	0.114	0.084
	(0.87)	(0.22)	(1.07)	(0.80)
Hispanic	0.305	0.385	0.280	0.383
	(1.61)	(2.00)**	(1.47)	(2.00)**
Commissioning Source-MECEP	-0.156	-0.243	-0.195	-0.235
	(0.83)	(1.26)	(1.03)	(1.21)
Commissioning Source-ECP	-0.312	-0.365	-0.322	-0.331
	(1.96)*	(2.27)**	(2.02)**	(2.05)**
	(0.93)	(0.91)	(1.11)	(0.81)
Commissioning Fiscal Year	YES	YES	YES	YES
Lambda (λ)	-.430	-.721	-.476	-.769
	(.237)*	(.280)***	(.237)**	(.279)***
Constant	100.797	101.074	100.878	100.805
	(192.89)***	(180.68)***	(192.18)***	(179.94)***
Observations	10013	10276	10013	10252
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Inverse mills ratios in all of the model specifications in the Heckman procedure for the PI outcomes at O-5 are insignificant. Thus, for O-5 there is no bias due to sample selection. Ergun (2003) does not analyze the determinants of the PI for O-5. His rationale is that performance in O-5 is inflated by supervisors. Grade inflation may also be caused by the fact that officers who performed well in their previous grades are selected as O-5s.

Heckman results including selection equation coefficient estimates for O-4 and O-5 are presented in Appendix B.

Note that coefficients of variables in the OLS regression results range from -1 to +3. Since they are measured on a scale from 0 to 100, although the estimated effects of the focus variables are statistically significant, they seem to be economically insignificant. Before reaching a conclusive judgment, one should take into account that the dependent variable, PI, is right-skewed and the variation is very low, since almost all of the officers received grades above 90.

B. SUPERVISOR FAVORITISM MODEL ESTIMATES

1. Descriptive Statistics

The supervisor favoritism model utilizes a different sample that includes direct observations on the supervisors' marital status. As discussed in the third chapter, the focus variables are formed by matching the marital status of recorded officers and that of reporting seniors. Table 34 presents the sample means for the control variables by each focus variable. The distribution of the variables is similar to that of the panel data utilized for the PI models in the previous section.

Table 34. Sample means by marital matching in supervisor favoritism sample

Variables	Married2Married	Single2Single	Married2Single	Single2Married
PI	98.612	98.447	98.592	98.346
Commissioning Age	24.421	22.885	22.928	24.235
White	0.874	0.880	0.879	0.856
African American	0.052	0.047	0.050	0.058
Hispanic	0.045	0.040	0.037	0.050
Other Race	0.029	0.034	0.034	0.036
TBS Class Percentile	56.641	50.559	50.755	55.421
Commissioning Source-NROTC	0.142	0.251	0.243	0.164
Commissioning Source-PLC	0.380	0.398	0.411	0.399
Commissioning Source-OCC	0.220	0.193	0.184	0.233
Commissioning Source-MECEP	0.124	0.010	0.011	0.100
Commissioning Source-ECP	0.084	0.019	0.019	0.066

2. Panel OLS (POLS) Estimates

Table 35 presents the results of POLS and FE estimates for the supervisor favoritism models. Model 1 focuses on the association between the marital statuses of recording seniors and these of their subordinates who received the performance evaluations, by controlling the same variables used in the first section, except the first GCR score. This model can only explain 7 percent of the variation in the PI. According to these results, married supervisors give slightly better fitreps to married officers than to single officers. On the other hand, single supervisors give single officers much higher fitreps than married reporting seniors. In the second model, recorded officers' rifle, pistol, and pft scores are included and the r-square of the model is improved to 12 percent. These new control variables are used as a proxy for physical ability for job performance, which may change over time. After adding these variables, the impact of the marital matching variables are not affected. The new coefficients of new variables are significant at the 0.01 level. The Pft score has the highest impact on the PI when compared to pistol and rifle scores. One unexpected result is that the rifle score has a negative sign. However, the most striking result is that, after controlling for individual-specific characteristics of the reporting officers by using the FE method, supervisor favoritism turns out to be "supervisor unfavoritism" for married officers by married supervisors. Married supervisors evaluate their single subordinates better than their married ones. The difference is 0.19 points in favor of single officers at a 1 percent significance level. Thus, these result rules out the possibility that the robust marriage premium found in the PI in the previous section is due to supervisor favoritism.

Table 35. POLS and FE estimates for Supervisor Favoritism Models in PI

	Model-1 (POLS)	Model-2 (POLS)	Model-3 (FE)
Variables	PI	PI	PI
Married to Married	0.425	0.347	-0.195
	(6.48)***	(5.29)***	(2.70)***
Single to Single	0.264	0.292	0.056
	(4.29)***	(4.71)***	(1.55)
Married to Single	0.409	0.331	N/A
	(7.19)***	(5.84)***	N/A
Rifle Scores	N/A	-0.001	N/A
	N/A	(8.72)***	N/A
Pistol Scores	N/A	0.001	0.001
	N/A	(6.23)***	(5.86)***

Table 35. POLS and FE estimates for Supervisor Favoritism Models in PI (Cont.)

	Model-1 (POLS)	Model-2 (POLS)	Model-3 (FE)
Variables	PI	PI	PI
Physical Fitness Test Scores	N/A	0.007	0.006
	N/A	(35.06)***	(32.95)***
Commissioning Age	-0.021	-0.032	N/A
	(2.03)**	(3.03)***	N/A
African American	-0.431	-0.460	N/A
	(4.10)***	(4.04)***	N/A
Hispanic	-0.124	-0.079	N/A
	(1.41)	(0.85)	N/A
Other Race	-0.122	-0.096	N/A
	(1.46)	(1.11)	N/A
TBS Class Percentile	0.027	0.026	N/A
	(42.93)***	(40.10)***	N/A
Commissioning Source-ROTC	-0.040	-0.035	N/A
	(0.80)	(0.68)	N/A
Commissioning Source-PLC	0.042	-0.096	N/A
	(0.86)	(1.91)*	N/A
Commissioning Source-OCC	-0.133	-0.163	N/A
	(2.35)**	(2.77)***	N/A
Commissioning Source-MEEP	-0.057	-0.527	N/A
	(0.64)	(5.60)***	N/A
Commissioning Source-ECP	-0.240	-0.615	N/A
	(2.39)**	(5.90)***	N/A
	(2.56)**	(2.51)**	N/A
Commissioning Fiscal Year	YES	YES	YES
Constant	96.492	95.557	97.115
	(167.07)***	(174.98)***	(3360.27)***
Observations	74346	67433	67433
F-stat	261.87	345.67	411.78
R-squared	0.08	0.14	0.07
Number of officers	14771	14771	14771
Note 1: Robust t statistics in parentheses			
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%			

C. PROMOTION TO O-4 MODEL ESTIMATES

1. Descriptive Statistics

Table 36 presents sample means of control variables used in the O-4 promotion model. According to these statistics, married and single officers who survive until the O-4 promotion board are quite similar in their commissioning age. White officers are the majority of the race group at approximately 90 percent. The single officers have the highest TBS class rank percentile with 58.92, and married officers follow them with 56.84. Interestingly, a majority of the divorced officers are PLC graduates.

Table 36. Sample Means by Focus Variables in O-4 Promotion Model

Variable	Married	Single	Divorced	To be married	Number of Non-spousal Dependents	Accumulated marriage years
Commissioning Age	23.466	23.857	22.641	23.099	23.106	22.642
White	0.915	0.929	0.903	0.912	0.913	0.905
African American	0.043	0.033	0.042	0.041	0.041	0.038
Hispanic	0.025	0.022	0.025	0.024	0.023	0.027
Other Race	0.018	0.016	0.030	0.023	0.023	0.030
TBS Class Percentile	56.841	58.920	53.386	55.296	55.877	55.476
GCT Score	129.209	129.593	129.232	129.294	129.319	129.323
Commissioning Source-USNA	0.093	0.077	0.124	0.106	0.108	0.134
Commissioning Source-NROTC	0.180	0.159	0.240	0.204	0.203	0.248
Commissioning Source-PLC	0.392	0.365	0.454	0.413	0.402	0.431
Commissioning Source-OCC	0.207	0.170	0.150	0.192	0.201	0.150
Commissioning Source-MECEP	0.063	0.124	0.012	0.039	0.038	0.014
Commissioning Source-ECP	0.065	0.104	0.021	0.045	0.046	0.023

2. Simple Probit Estimates

Table 37 presents simple probit estimates of promotion to the O-4 model. There are four different model specifications in which we test the four different hypotheses mentioned in Chapter 4. In this section, we discuss the estimation results of the focus

variables and the control variables in four different models. The model specifications are identical except for the focus variables.

In the first model, Hypothesis 6 is tested to determine whether there is a premium related to being married in the promotion board outcome. Different from the PI model specification, divorced officers are included in the unmarried officer group, since we focus on the effect of being married or not being married at the promotion board. Simple probit regression results for the first model indicate that being married has a positive and highly significant effect at the .01 level on promotion to O-4. Moreover, married officers have 0.031 (3.6%) more promotion probability than unmarried officers (including both single and divorced officers).

In the second model, the seventh hypothesis is tested to determine whether accumulated years of marriage has an effect on O-4 promotion. Simple probit regression results for the second model indicate that each additional year in marriage provides 0.002 (0.23%) higher promotion probabilities at a 5 percent significance level.

In the third model, the results reveal that the promotion probability of male U.S. Marine Corps officers to O-4 is 0.052 (6%) higher for each additional non-spousal dependent. This result is highly significant and consistent with what Hill (1979) and Mehay and Bowman (2004) report in their studies. Both draw attention to the positive effect of having non-spousal dependents.

The fourth model focuses on the difference between married and "to-be-married" officers. The estimation results of this model reveal that "to-be-married" officers have higher O-4 promotion rates (significant at a .01 level) when compared to "to-be-single" officers. More specifically, married officers have a 0.035 (3.97%) higher promotion probability than unmarried ones, and "to-be-married" officers have a 0.076 (8.87%) higher promotion probability then the base case, "to-be-single" officers.

In all four models the control variables are significant. They are TBS overall class rank percentiles and no promote recommendation status. This result is consistent with Ergun's (2003) results. TBS class rank percentiles have a positive effect on O-4 promotion in each model. Other significant variables are accelerated promotion recommendation status, NROTC, PLC, MECEP, and ECP. Another remarkable result is

the insignificant results associated with the race variables. It seems that there is no significant difference among promotion rates of different races. This result undermines concerns about racism and discrimination in the military.

Table 37. Probit Models of Promotion to O- 4

	Model-1	Model-2	Model-3	Model-3
Variables	Hypothesis-6	Hypothesis-7	Hypothesis-8	Hypothesis-9
Married at O-3	0.132	N/A	N/A	0.148
	(3.76)***	N/A	N/A	(4.15)***
	[0.031]	N/A	N/A	[0. 034]
Accumulated Marriage Years At O-4	N/A	0.009	N/A	N/A
	N/A	(2.37)**	N/A	N/A
	N/A	[0.002]	N/A	N/A
Number of Non-Spousal dependents at O-4	N/A	N/A	0.231	N/A
	N/A	N/A	(11.56)***	N/A
	N/A	N/A	[0.052]	N/A
To be married at O-3	N/A	N/A	N/A	0.366
	N/A	N/A	N/A	(9.19)***
	N/A	N/A	N/A	[0. 076]
African American	-0.045	-0.041	-0.052	-0.044
	(0.56)	(0.51)	(0.64)	(0.54)
Hispanic	-0.114	-0.109	-0.129	-0.133
	(1.11)	(1.06)	(1.24)	(1.28)
Other Race	-0.041	-0.042	-0.016	-0.071
	(0.38)	(0.39)	(0.15)	(0.65)
TBS Class Percentile	0.005	0.005	0.005	0.005
	(8.46)***	(8.55)***	(8.19)***	(8.22)***
	[0.001]	[0.001]	[0.001]	[0. 001]
Receiving Accelerated Promotion	0.265	0.267	0.177	0.285
	(1.83)*	(1.85)*	(1.19)	(1.95)*
	[0.053]	[0.053]		[0. 056]
Receiving NO Promotion	-0.667	-0.664	-0.631	-0.653
	(2.20)**	(2.19)**	(2.07)**	(2.14)**
	[-0.204]	[-0.203]	[-0.187]	[-0. 197]

Table 37. Probit Models of Promotion to O- 4 (Cont.)

	Model-1	Model-2	Model-3	Model-3
Variables	Hypothesis-6	Hypothesis-7	Hypothesis-8	Hypothesis-9
Commissioning Source-NROTC	-0.106	-0.108	-0.103	-0.101
	(1.68)*	(1.71)*	(1.62)	(1.59)
	[-0.205]	[-0.026]		
Commissioning Source-PLC	-0.104	-0.109	-0.112	-0.090
	(1.81)*	(1.91)*	(1.93)*	(1.56)
	[-0.204]	[-0.025]	[-0. 025]	
Commissioning Source-OCC	0.066	0.063	0.037	0.098
	(1.01)	(0.96)	(0.56)	(1.49)
Commissioning Source-MECEP	-0.018	-0.026	-0.211	0.063
	(0.17)	(0.25)	(1.98)**	(0.59)
			[-0. 052]	
Commissioning Source-ECP	0.142	0.128	0.025	0.209
	(1.37)	(1.24)	(0.24)	(2.01)**
Rho (ρ)	(0.46)	(0.48)	(0.48)	(0.48)
	(0.09)***	(0.09)***	(0.09)***	(0.09)***
Constant	0.719	0.757	0.691	0.604
	(10.92)***	(11.62)***	(10.87)***	(8.97)***
Observations	8587	8644	8644	8587
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				
Note 3: Numbers in brackets indicate marginal effects				

3. MLPE with Selection Estimates

Table 38 presents maximum-likelihood probit estimates (MLPE) with selection results of promotion to O-4. The MLPE results, including selection equation coefficient estimates for O-4, are presented in Appendix C. The four hypotheses are tested again with four different models as in the simple probit section. In fact, retention decisions of U.S. Marine Corps officers influence the estimation results with simple probit after O-4. The retention decision is the main cause for sample selection bias due to non-random selection into staying in service till O-4.

The probit model with sample selection (Van de Ven and Van Pragg, 1981) assumes that there exists an underlying relationship between the probit equation and the selection equation, such that we observe only the binary outcome. The dependent variable, however, is not always observed. It is observed when the dependent variable of the selection equation is observed. And the term rho (ρ) is supposed to equal the correlation between the error terms of two equations. Whenever $\rho \neq 0$, then probit applied to the first equation yields unbiased results. MLPE provides consistent, asymptotically efficient estimates for all the parameters in such models.

MLPE results in Table 39. for the first model indicate that being married has a positive and highly significant effect on promotion to O-4. The sixth hypothesis is tested and married officers are found to have 0.033 (4%) higher promotion probabilities than unmarried ones (including both single and divorced men).

In the second model, the seventh hypothesis is tested to determine whether marriage has a dynamic productivity enhancing structure as claimed by Kenny (1983), Korenmark and Neumark (1991), and Mehay and Bowman (2004), after controlling for selection bias arising from retention. MLPE results for the second model indicate that each additional year in marriage provides a 0.023 (2.78%) higher promotion probability.

In the third model, the results reveal that each additional non-spousal dependent increases the promotion probabilities of male U.S. Marine Corps officers by 0.056 (6.63%). This result is highly significant and consistent with what Hill (1979) and Mehay and Bowman (2004) report in their studies.

The fourth model focuses on the difference between married and "to-be-married" officers. The estimation results of this model reveal that "to-be-married" officers have a 0.09 (10.69%) higher O-4 promotion probability then "to-be-single" officers. The coefficient for married is 0.038 (4.51%).

In all four models the same control variables are observed to have significant estimation results. Similar to Ergun's (2003) results, TBS class rank percentiles have a positive effect on O-4 promotion in each model. On the other hand, in different models

NROTC and ECP graduates are found to be significant, too. Similar to the results with the simple probit model, race is insignificant. This result reveals that there is no difference among promotion rates of different races, even after controlling for selection bias.

Overall, we can say that controlling for selection bias does not result in any major difference from the simple probit estimates. On the other hand, the rho (ρ) term is significant and positive in all models, which shows that there is an upward bias in single probit estimations.

Table 38. MLPE with Selection results of promotion to O-4 models

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
Married at O-3	0.129	N/A	N/A	0.143
	(3.94)***	N/A	N/A	(4.31)***
	[0.339]	N/A	N/A	[0.038]
Accumulated Marriage Years At O-4	N/A	0.009	N/A	N/A
	N/A	(2.47)**	N/A	N/A
	N/A	[0.023]	N/A	N/A
Number of Non-Spousal dependents at O-4	N/A	N/A	0.218	N/A
	N/A	N/A	(11.08)***	N/A
	N/A	N/A	[0.056]	N/A
To be married at O-3	N/A	N/A	N/A	0.341
	N/A	N/A	N/A	(8.86)***
	N/A	N/A	N/A	[0.090]
African American	-0.081	-0.076	-0.089	-0.080
	(1.05)	(0.99)	(1.16)	(1.04)
Hispanic	-0.119	-0.115	-0.134	-0.137
	(1.22)	(1.18)	(1.37)	(1.40)
Other Race	-0.047	-0.048	-0.025	-0.074
	(0.46)	(0.47)	(0.25)	(0.72)
TBS Class Percentile	0.007	0.007	0.007	0.007
	(10.75)***	(10.68)***	(10.77)***	(10.70)***
	[0.001]	[0.001]	[0.001]	[0.001]

Table 38. MLPE with Selection results of promotion to O-4 models (Cont.)

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
Commissioning Source-NROTC	-0.101	-0.102	-0.095	-0.097
	(1.69)*	(1.70)*	(1.57)	(1.61)
	[-0.032]	[-0.032]		
Commissioning Source-PLC	-0.112	-0.116	-0.116	-0.098
	(2.05)**	(2.11)**	(2.13)**	(1.79)*
	[-0.210]	[-0.210]	[-0.022]	[-0.018]
Commissioning Source-OCC	0.016	0.017	-0.013	0.043
	(0.26)	(0.27)	(0.20)	(0.68)
Commissioning Source-MECEP	0.136	0.124	-0.027	0.219
	(1.26)	(1.15)	(0.25)	(2.04)**
				[0.036]
Commissioning Source-ECP	0.197	0.184	0.094	0.262
	(1.98)**	(1.85)*	(0.94)	(2.64)***
	[0.060]	[0.056]		[0.073]
Constant	0.297	0.348	0.231	0.172
	(2.63)***	(3.04)***	(2.13)**	(1.57)
Observations	14116	14170	14170	14116
Note 1: Absolute value of z statistics in parenthes				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				
Note 3: Numbers in brackets indicate marginal effects				

D. PROMOTION TO O-5 MODEL ESTIMATES

1. Descriptive Statistics

Table 39 presents sample means of variables used in promotion to O-5 models. These statistics yield similar results with the one computed for O-4. According to these statistics, married and single officers who survive until the O-5 board are similar in commissioning age. White officers are 93 percent of the race group. However, in this sample, married officers have the highest TBS class rank percentile with 60.386, compared to single officers with a 59.622 average. PLC is again the most common commissioning source among all sources, with approximately 39 percent.

Table 39. Sample Means by Focus Variables in O-5 Promotion Model

Variable	Married	Single	Divorced	To_be_married	Numkidsprev	Accmaryear
Commissioning Age	23.252	23.248	22.681	22.626	23.064	23.040
White	0.946	0.924	0.929	0.928	0.942	0.942
African American	0.030	0.034	0.033	0.026	0.031	0.031
Hispanic	0.016	0.034	0.012	0.016	0.014	0.014
Other Race	0.008	0.008	0.026	0.030	0.013	0.013
TBS Class Percentile	60.386	59.622	58.741	59.877	59.702	59.878
GCT Score	129.530	130.103	130.011	130.272	129.770	129.813
Commissioning Source-USNA	0.094	0.093	0.134	0.136	0.107	0.108
Commissioning Source-NROTC	0.169	0.161	0.186	0.189	0.176	0.178
Commissioning Source-PLC	0.360	0.390	0.396	0.391	0.372	0.371
Commissioning Source-OCC	0.284	0.203	0.256	0.252	0.273	0.272
Commissioning Source-MECEP	0.029	0.076	0.001	0.007	0.020	0.020
Commissioning Source-ECP	0.065	0.076	0.027	0.024	0.052	0.051

2. Simple Probit Estimates

Table 40 presents simple probit estimates of promotion to the O-5 model. There are four different model specifications in which we test the four different hypotheses. In this section we discuss the estimation results of the focus variables and the control variables in four different models.

In the first model Hypothesis 6 is tested to determine whether there is any potential premium related to being married in the O-5 promotion board outcome. Simple probit regression results for the first model indicate that being married has a positive and significant effect on promotion to O-5, at the .05 level. Furthermore, married officers have a 0.068 (10.05%) higher promotion probability than unmarried officers.

The second model tests Hypothesis 7 to determine whether the number of marriage years has any effect on promotion to O-5, or not. However, simple probit regression results for the second model do not reveal any significant result associated with this focus variable.

In the third model, the results reveal that the promotion probabilities of male U.S. Marine Corps officers to O-5 increase by 0.076 (10.90%) with each additional non-spousal dependent. This result is highly significant and is consistent with what Hill (1979) and Mehay and Bowman (2004) report in their studies.

The fourth model tests Hypothesis 9 and focuses on the difference between married and "to-be-married" officers. The estimation results of this model reveal that "to-be-married" officers have a 0.08 (11.83%) higher O-5 promotion probability then the "to-be-single" officers. The coefficient for the married officers is found to be 0.064 (9.46%) in the same model.

In all four models, four control variables are significant at traditional significance levels. They are TBS class rank percentiles, OCC, MECEP, and ECP commissioning sources. There are insignificant results associated with the race variables. It seems that there is no significant difference in different races for promotion rates, and the concerns about racism and discrimination in the military are not realistic.

Table 40. Probit Models of Promotion to O-5

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
Married at O-3	0.184	N/A	N/A	0.174
	(1.93)*	N/A	N/A	(1.81)*
	[0. 068]	N/A	N/A	[0. 064]
Accumulated Marriage Years At O-4	N/A	-0.003	N/A	N/A
	N/A	(0.46)	N/A	N/A
Number of Non-Spousal dependents at O-4	N/A	N/A	0.216	N/A
	N/A	N/A	(7.62)***	N/A
	N/A	N/A	[0. 076]	N/A
To be married at O-3	N/A	N/A	N/A	0.231
	N/A	N/A	N/A	(2.87)***
	N/A	N/A	N/A	[0. 080]

Table 40 Probit Models of Promotion to O-5 (Cont.)

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
African American	0.171	0.061	0.107	0.180
	(0.92)	(0.34)	(0.59)	(0.97)
Hispanic	0.379	0.232	0.179	0.373
	(1.35)	(0.86)	(0.66)	(1.33)
Other Race	-0.168	-0.183	-0.126	-0.226
	(0.62)	(0.68)	(0.46)	(0.83)
TBS Class Percentile	0.005	0.005	0.005	0.005
	(4.39)***	(4.34)***	(4.16)***	(4.27)***
Receiving Accelerated Promotion	0.303	0.289	0.229	0.299
	(1.99)**	(1.92)*	(1.50)	(1.96)**
	[0. 101]	[0. 094]	[-0. 095]	[0. 100]
Commissioning Source-NROTC	-0.018	-0.023	-0.009	-0.002
	(0.14)	(0.18)	(0.07)	(0.01)
Commissioning Source-PLC	-0.159	-0.161	-0.157	-0.136
	(1.38)	(1.44)	(1.39)	(1.17)
Commissioning Source-OCC	-0.220	-0.244	-0.264	-0.189
	(1.86)*	(2.13)**	(2.27)**	(1.59)
Commissioning Source-MECEP	-0.844	-0.855	-1.007	-0.786
	(3.67)***	(3.73)***	(4.33)***	(3.40)***
	[-0.326]	[-0. 330]	[-0. 385]	[-0. 305]
Commissioning Source-ECP	-0.464	-0.499	-0.581	-0.413
	(2.76)***	(3.02)***	(3.50)***	(2.44)**
	[-0.178]	[-0. 190]	[-0. 221]	[-0.158]
Constant	0.115	0.382	0.049	0.060
	(0.76)	(2.84)***	(0.37)	(0.39)
Observations	1692	1828	1828	1692
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				
Note 3: Numbers in brackets indicate marginal effects				

3. MLPE with Selection Estimates

Table 41 presents maximum-likelihood probit estimates (MLPE) results of promotion to O-5. The MLPE results, including selection equation coefficient estimates for O-5, are presented in Appendix C. Due to the expected selection bias and in order to find more realistic results, MLPE with selection is preferred.

In the first model, Hypothesis 6 is tested and the test results reveal a slightly significant premium related to being married in O-5. MLPE results for the first model indicate that being married has a positive but slightly significant effect at the .10 level on promotion to O-5. Married officers are found to have a 0.076 (12.37%) higher promotion probability than the unmarried officers.

MLPE results for the second model do not reveal any significant result associated with the focus variable. Non-spousal dependents' effect on promotion to O-5 is tested with the third model. The estimate results reveal that the promotion probabilities of male U.S. Marine Corps officers to O-5 increase by 0.067 (11.94%) with each additional non-spousal dependent. This result is highly significant at the .05 level and is consistent with prior literature about the effect of non-spousal dependents.

The fourth model MLPE results reveal that "to-be-married" officers have a 0.08 (12%) higher O-5 promotion probability than the "to-be-single" officers.

The model specifications used in all four models are similar. TBS class rank percentiles, accelerated promotion recommendation, commissioning sources of OCC, and MECEP are the significant variables observed in all four models. The basic school class rank percentages have a positive effect on O-4 promotion in each model. There is no significant difference in different races for promotion rates.

Overall, we can say that controlling for selection bias does not result in any major difference from the simple probit estimates for O-5 promotion models. To the contrary, simple probit estimates have more significant results than MLPE results. Nevertheless, the rho (ρ) term is significant and positive in all models, which explains an upward bias.

Table 41. MLPE with Selection Results of Promotion to O-5 Models

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
Married at O-4	0.085	N/A	N/A	0.072
	(2.07)**	N/A	N/A	(1.72)*
	[0.076]	N/A	N/A	[0.062]
Accumulated Marriage Years At O-5	N/A	0.001	N/A	N/A
	N/A	(0.27)	N/A	N/A
Number of Non-Spousal Dependents at O-5	N/A	N/A	0.082	N/A
	N/A	N/A	(6.10)***	N/A
	N/A	N/A	[0.067]	N/A
To be married at O-4	N/A	N/A	N/A	0.056
	N/A	N/A	N/A	(1.97)**
	N/A	N/A	N/A	[0.048]
African American	0.032	-0.023	0.001	0.030
	(0.31)	(0.22)	(0.01)	(0.29)
Hispanic	0.172	0.107	0.076	0.171
	(1.11)	(0.69)	(0.49)	(1.11)
Other Race	-0.042	-0.046	-0.021	-0.056
	(0.24)	(0.27)	(0.13)	(0.33)
TBS Class Percentile	0.010	0.009	0.009	0.010
	(13.16)***	(13.16)***	(13.07)***	(13.00)***
	[0.0025]	[0.0024]	[0.0025]	[0.0024]
Receiving Accelerated Promotion	0.679	0.661	0.634	0.680
	(6.27)***	(6.19)***	(5.92)***	(6.17)***
	[0.116]	[0.116]	[0.104]	[0.123]
Receiving NO-Promotion	-5.211	-8.190	-8.410	-7.886
	(0.01)	(0.01)	(0.01)	(0.01)
Commissioning Source-NROTC	-0.025	-0.015	-0.005	-0.021
	(0.33)	(0.20)	(0.06)	(0.28)
Commissioning Source-PLC	-0.108	-0.095	-0.087	-0.103
	(1.58)	(1.43)	(1.30)	(1.50)
Commissioning Source-OCC	-0.136	-0.137	-0.140	-0.128
	(1.93)*	(1.99)**	(2.02)**	(1.81)*

Table 41. MLPE with Selection Results of Promotion to O-5 Model (Cont.)

	Model 1	Model 2	Model 3	Model 4
Variables	Hypothesis 6	Hypothesis 7	Hypothesis 8	Hypothesis 9
Commissioning Source-MECEP	-0.655	-0.686	-0.733	-0.638
	(4.33)***	(4.55)***	(4.84)***	(4.20)***
Commissioning Source-ECP	-0.103	-0.127	-0.151	-0.087
	(0.92)	(1.15)	(1.36)	(0.78)
Constant	-1.345	-1.204	-1.328	-1.348
	(16.11)***	(15.78)***	(17.52)***	(12.37)***
Observations	5436	5563	5563	5436
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				
Note 3: Numbers in brackets indicate marginal effects				

E. 10-YEAR RETENTION MODEL ESTIMATES

1. Descriptive Statistics

Table 42 presents the sample means of control variables by marital status. Single officers are approximately 1 year younger than married officers and 2 years younger than divorced officers at commissioning. Interestingly, divorced officers have higher TBS class rank percentiles. Approximately 96 percent of the divorced officers are white and approximately half of the single officers are PLC graduates. Aviation MOS are the most dominant MOS group among the married officers and single officers who will marry in the future. Among single officers, Combat MOS are the most common MOS group.

Table 42. Sample Means by Marital Status for 10 Year Retention Sample

	Married_acc	Divorced_acc	Single_acc	To_be_married
Commissioning Age	23.563	24.701	22.635	22.788
White	0.910	0.962	0.895	0.90
African American	0.049	0.013	0.049	0.042
Hispanic	0.025	0.025	0.026	0.029
Other Race	0.016	0.001	0.029	0.029
GCT Score	29.109	130.893	128.864	128.659
TBS Class Percentile	53.520	58.252	49.404	53.023
Prior Enlisted	0.190	0.380	0.074	0.082

Table 42 Sample Means by Marital Status for 10 Year Retention Sample (Cont.)

	Married_acc	Divorced_acc	Single_acc	To_be_married
Commissioning Source-USNA	0.081	0.037	0.117	0.137
Commissioning Source-NROTC	0.157	0.152	0.225	0.244
Commissioning Source-PLC	0.394	0.304	0.458	0.456
Commissioning Source-OCC	0.23	0.228	0.172	0.133
Commissioning Source-MECEP	0.063	0.139	0.007	0.011
Commissioning Source-ECP	0.069	0.139	0.020	0.019
Combat MOS	0.283	0.291	0.373	0.335
Group Support MOS	0.202	0.139	0.161	0.146
Service MOS	0.131	0.165	0.101	0.097
Aviation MOS	0.308	0.203	0.298	0.362
Aviation Support MOS	0.096	0.228	0.080	0.071

2. Simple Probit Estimates

The coefficients, standard errors, and marginal effects of the variables in the simple probit estimation of the 10-year retention models are shown in Table 43. The first model presents the effect of marital status at accession on the likelihood to retain. Being married increases the probability to retain by 0.077 (13.41%) when compared to being single, all else equal. Being divorced also has a positive sign, but it is not statistically significant. The second model analyzes the effect of each non-spousal dependent at the accession point on the retention decision of officers. Results indicate that each additional non-spousal dependent increases the retention probability by 0.054 (9.4%), all else equal. In the third model, single officers who will marry later in their careers have a 0.418 (72.82%) higher probability to retain 10 years in service than single officers who will stay single in the future. Officers who are married at accession also have a 0.309 (53.83%) higher retention probability than "to-be-single" officers. In other words, married officers and single officers who will marry are more likely to retain than officers

who do not plan to get married. All focus variables, except being divorced, are significant at a 1-percent significance level. These results are consistent with Kol and Ryu's (2002) retention estimations in which they report that the premium in the likelihood to retain until the O-4 for married male navy officers is 9 percentage points higher for URL and 19 percentage points higher for the STF/RL officers.

The coefficients of all other control variables have similar effects on retention. Each additional year of age at commissioning increases the retention probability by approximately 0.02 (3.3%), all else equal. As expected, being prior enlisted increases the retention probability as compared to officers who are not prior enlisted. All MOS groups, except the aviation MOS group, have negative effects on retention when compared to combat MOS group. Belonging to PLC and OCC commissioning sources affects retention probability negatively when compared to the USNA. The effect of the MECEP commissioning source is positive. Graduates of this commissioning program have 0.383 (66.7%) higher retention rates than USNA graduates.

Table 43. Probit Models of 10 Year Retention

Variables	Model-1	Model 2	Model 3
Married at Accession	0.197	N/A	0.827
	(7.42)***	N/A	(25.49)***
	[0.077]	N/A	[0.309]
Divorced at Accession	0.216	N/A	N/A
	(1.23)	N/A	N/A
Number of Non-spousal Dependents at O-1	N/A	0.137	N/A
	N/A	(4.93)***	N/A
	N/A	[0.054]	N/A
To be married at O-1	N/A	N/A	1.183
	N/A	N/A	(35.41)***
	N/A	N/A	[0.418]
Commissioning Age	0.049	0.052	0.045
	(5.39)***	(5.66)***	(4.80)***
African American	0.020	0.010	0.019
	(0.32)	(0.15)	(0.29)
Hispanic	0.027	0.023	0.003
	(0.33)	(0.28)	(0.04)

Table 43. Probit Models of 10 Year Retention (Cont.)

Variables	Model-1	Model 2	Model 3
Other Race	-0.003	-0.001	-0.029
	(0.03)	(0.01)	(0.33)
GCT Score	-0.005	-0.005	-0.003
	(3.70)***	(3.60)***	(2.15)**
TBS Class Percentile	0.005	0.005	0.004
	(10.30)***	(10.56)***	(7.86)***
Prior Enlisted	0.240	0.226	0.187
	(3.83)***	(3.56)***	(2.87)***
Commissioning Source-NROTC	-0.003	-0.015	0.039
	(0.06)	(0.32)	(0.83)
Commissioning Source- PLC	-0.107	-0.108	-0.019
	(2.48)**	(2.45)**	(0.42)
Commissioning Source-OCC	-0.282	-0.271	-0.127
	(5.56)***	(5.26)***	(2.40)**
Commissioning Source-MECEP	0.383	0.408	0.529
	(3.38)***	(3.55)***	(4.58)***
Commissioning Source-ECP	0.049	0.066	0.245
	(0.49)	(0.64)	(2.36)**
Group Support MOS	-0.084	-0.071	-0.113
	(2.38)**	(1.99)**	(3.07)***
Service Support MOS	-0.146	-0.122	-0.204
	(3.47)***	(2.84)***	(4.64)***
Aviation MOS	0.461	0.467	0.367
	(14.66)***	(14.80)***	(11.24)***
Aviation Support MOS	-0.097	-0.085	-0.098
	(2.11)**	(1.84)*	(2.05)**
Constant	-0.670	-0.702	-1.455
	(2.40)**	(2.49)**	(5.02)***
Observations	11028	10853	11028
Note 1: Absolute value of z statistics in parenthese			
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%			
Note 3: Numbers in brackets indicate marginal effects			

F. CHAPTER SUMMARY

This chapter presented multivariate regression results of four different performance measures: performance indexes, supervisor favoritism, promotion to O-4/ O-5, and retention. Four different hypotheses are tested with different models by using panel OLS, fixed effects, and the Heckman estimating techniques. Overall, in order to better interpret the estimation results of simple probit and MLPE of each variable in these models, marginal effects of these variables are also computed.

For the PI models, panel OLS results indicate significant and positive results for all focus variables. However, divorced officers are predicted to have more PIs then singles and being both married and divorced together with non-spousal dependents yielded negative effects on PIs. Fixed effect estimates for PIs generated higher coefficients for all focus variables. On the other hand, the Heckman estimates in O-4 PI produced a lower marriage premium. Heckman estimation results, which include selection equation estimates, are presented in Appendix B. For the O-5, Heckman estimations do not indicate any selection bias.

The results of panel OLS for the test of supervisor favoritism revealed that married supervisors give slightly better fitreps to married officers than single officers. But single supervisors are found to give higher fitreps to single officers than to married officers. Surprisingly, FE estimates revealed that single officers receive better fitreps from married supervisors than do married officers. Thus we reject the hypothesis that the marriage premium, which is found to be robust in the PI models, is caused by supervisor favoritism.

Both promotion to O-4 and O-5 models produced similar results with simple probit and MLPE techniques. For O-4 all four focus variables were significant and had positive effects in both the simple probit and MLPE with sample selection estimates. However, for the O-5, second hypothesis is found to be insignificant. Accumulated marriage years have no significant effect on promotion to O-5 both in simple probit and MLPE with selection estimates.

The 10-YCS retention model is estimated with simple probit. Being married is found to have a significant and positive effect on retention of 10 YCS. In addition, "to-be-married" officers are found to be more likely to stay than "to-be-single" men. The next chapter includes a summary of the study conclusions and provides recommendations.

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VI. CONCLUSIONS AND RECOMMENDATIONS

This study sheds light primarily on the effect of marital status and number of non-spousal dependents as effective factors on performance and on-the-job productivity of U.S. Marine Corps officers. In addition to those two factors, the effect of personal characteristics, job related characteristics, and commissioning sources are also analyzed in this study. Mainly, four performance measures are used as a proxy for performance and on-the-job productivity: performance indexes (PIs), promotion to O-4, promotion to O-5, and 10 years retention. Simple probit, panel OLS, fixed effect, Heckman, and maximum likelihood probit estimators with selection techniques are used in this study.

Simple T-test statistics reveal that male USMC officers receive higher evaluation scores from their supervisors, have more 10-year retention rates, and have more promotion rates to O-4 and O-5.

The analysis of the effect of marital status reveals that married officers have an approximately 1 point higher PI score, a 4-12 percentage point higher promotion probability, and 13 percentage points retention probability than single marine officers. Additionally, each additional year spent in marriage increases PI scores by .35 points and retention probability by 3 percentage points. Besides, having an additional non-spousal dependent increases performance evaluation scores by .4–1 points, promotion probability by 6-12 percentage points, and retention probability by 10 percentage points. On the other hand, "to-be-married" officers have the same or a higher premium as married officers for all productivity and performance indicators. This last finding supports the selectivity into marriage hypothesis as an explanation of the source of the marriage premium. A summary of the results found in the study is presented in Table 44.

Table 44. Summary of the Results by Partial Effects of the Focus Variables

Model	Technique	Married	Divorced	To be married	Accumulated marriage years	Number of non-spousal dependents
PI	POLS	0.716***	1.049***	0.832***	0.351***	0.954***
PI	FE	1.478***	2.237***	1.039***	0.364***	1.201***
PI (O-4)	Heckman	0.103*	0.035	0.646***	0.005	0.172***
Promotion to O-4	Simple Probit	0.031***	N/A	0.076***	0.002**	0.052***
Promotion to O-4	MLPE	0.339***	N/A	0.090***	0.023**	0.056***
Promotion to O-5	Simple Probit	0.068*	N/A	0. 080***	-0.006	0.076***
Promotion to O-5	MLPE	0.076**	N/A	0.048***	0.001	0.067**
10 Year Retention	Simple Probit	0.077***	0.086	0.418***	N/A	0.054***
Note 1: * significant at 10%; ** significant at 5%; *** significant at 1%						

The supervisor favoritism test reveals that married supervisors give married officers approximately the same evaluation scores they give single officers, while single supervisors give higher scores to single officers than to married officers. These results reject supervisor favoritism as an explanation for the marriage premium found in the PI scores of USMC officers.

The study finds that married male officers in U.S. Marine Corps are more productive and perform better than single male officers. Also, marriage is found to have a dynamic effect on productivity. It is also estimated that each additional non-spousal dependent increases performance and on-the-job productivity. The premium associated with marriage and family remains robust even after eliminating individual-specific characteristics. The test based on matching supervisors and their subordinates reveals that supervisor favoritism does not explain the marriage premium. However, the test of the differences among married, "to-be-married", and "to-be-single" men shows that a significant portion of the marriage premium is due to selectivity into marriage, which is the choice of more productive officers to marry, and unobservable factors correlated with both marriage and performance.

The robust effect of marriage and non-spousal dependents on performance, on-the-job productivity, and retention, provides a rationale for continuing military policies that provide benefits to married personnel. In the USMC, these policies are conducted under the name of Quality of Life (QOL) programs. The main QOL programs include the Child Care Program, Exceptional Family Member Program, Marriage Enrichment Program, Family Member Employment Program, and Youth and Teen Program. However, this study shows that a significant portion of the marriage premium is caused by selection into marriage by better-performing officers. Thus, the U.S. Marine Corps may benefit by conducting a full cost-benefit analysis of these programs.

The main drawback of the study is the lack of generalizability of data on marine officers to the civilian population. Another limitation is the lack of exact marriage dates. When performance in one particular rank is based on the marital status in a previous rank, it is assumed to represent the last marital status before promoting to that rank. Also, "the accumulated years of marriage" variable is calculated by assuming that the marriage event occurs in the middle of a given rank. Exact dates of marriage would provide a more precise estimate of the dynamic effect of marriage.

The dataset does not include any information on spouses. Spouses' labor market participation, work hours, and education level are found to be important in the prior literature. In addition, a survey of hours spent in household production by single and married male officers would be beneficial to understand the importance of household specialization theories for the explanation of USMC officers' marriage premium.

Finally, the data does not provide ages of non-spousal dependents. When analyzing the effect of dependents on productivity, such additional information will provide more precision and better understanding of the differentials caused by changes in family size.

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APPENDIX A. OLS ESTIMATES OF PI MODELS BY RANKS

Table 45. OLS Estimates of O-1 PI Models

	Model-1	Model-3	Model-4
	Hypothesis 1	Hypothesis 3	Hypothesis 4
Married	0.181	0.201	0.481
	(2.82)***	(3.04)***	(6.88)***
Divorced	0.029	-0.196	N/A
	(0.08)	(0.45)	N/A
Number of non-spousal dependents	N/A	-0.086	N/A
	N/A	(0.28)	N/A
Married and have non-spousal dependents	N/A	-0.018	N/A
	N/A	(0.06)	N/A
Divorced and have non-spousal dependents	N/A	0.492	N/A
	N/A	(0.85)	N/A
To be Married	N/A	N/A	0.659
	N/A	N/A	(10.25)***
Commissioning age	-0.005	-0.001	-0.009
	(0.28)	(0.01)	(0.54)
African American	-0.645	-0.651	-0.650
	(5.32)***	(5.31)***	(5.38)***
Hispanic	-0.232	-0.215	-0.243
	(1.62)	(1.50)	(1.70)*
Other Race	-0.403	-0.412	-0.384
	(2.52)**	(2.56)**	(2.41)**
Gct Score	-0.015	-0.014	-0.015
	(5.05)***	(4.83)***	(4.92)***
TBS Class-rank percentile	0.041	0.041	0.040
	(39.96)***	(39.53)***	(39.15)***
Commissioning Source-NROTC	-0.350	-0.349	-0.319
	(3.44)***	(3.38)***	(3.15)***
Commissioning Source-PLC	-0.164	-0.175	-0.133
	(1.74)*	(1.83)*	(1.41)
Commissioning Source-OCC	-0.052	-0.052	0.010
	(0.48)	(0.48)	(0.10)

Table 45. OLS Estimates of O-1 PI Models (Cont.)

Commissioning Source-MECEP	-0.419	-0.388	-0.350
	(2.28)**	(2.07)**	(1.91)*
Commissioning Source-ECP	-0.415	-0.430	-0.343
	(2.43)**	(2.48)**	(2.01)**
Commissioning Fiscal Year	YES	YES	YES
Constant	95.441	95.322	95.234
	(165.21)***	(163.78)***	(165.27)***
Observations	19971	19732	19971
F-stat	178.04	160.28	182.48
R-squared	0.21	0.21	0.22
Note 1: Absolute value of t statistics in parentheses			
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%			

Table 46. OLS Estimates of O-2 PI Models

	Model-1	Model-3	Model-4
	Hypothesis 1	Hypothesis 3	Hypothesis 4
Married	0.190	0.178	0.658
	(3.81)***	(3.38)***	(12.59)***
Divorced	0.343	0.299	N/A
	(0.85)	(0.56)	N/A
Number of non-spousal dependents	N/A	0.467	N/A
	N/A	(5.74)***	N/A
Married and have non-spousal dependents	N/A	-0.346	N/A
	N/A	(3.78)***	N/A
Divorced and have non-spousal dependents	N/A	-0.309	N/A
	N/A	(0.74)	N/A
To be Married	N/A	N/A	1.053
	N/A	N/A	(16.50)***
Commissioning age	-0.053	-0.059	-0.047
	(3.34)***	(3.67)***	(3.13)***
African American	-0.676	-0.686	-0.895
	(6.16)***	(6.26)***	(8.43)***
Hispanic	-0.131	-0.131	-0.145
	(1.07)	(1.07)	(1.14)
Other Race	-0.307	-0.309	-0.286
	(2.26)**	(2.28)**	(2.05)**
Gct Score	-0.016	-0.015	-0.017
	(5.81)***	(5.66)***	(6.63)***
TBS Class-rank percentile	0.025	0.024	0.029
	(26.73)***	(26.48)***	(33.53)***
Commissioning Source-NROTC	-0.203	-0.210	-0.265
	(2.26)**	(2.34)**	(3.06)***
Commissioning Source-PLC	-0.418	-0.415	-0.347
	(4.93)***	(4.90)***	(4.31)***
Commissioning Source-OCC	-0.172	-0.170	-0.195
	(1.73)*	(1.71)*	(2.12)**
Commissioning Source-MECEP	-0.109	-0.194	-0.083
	(0.66)	(1.15)	(0.52)

Table 46. OLS Estimates of O-2 PI Models (Cont.)

Commissioning Source-ECP	-0.225	-0.254	-0.304
	(1.38)	(1.55)	(2.03)**
Commissioning Fiscal Year	YES	YES	YES
Constant	93.598	97.666	96.866
	(98.27)***	(50.22)***	(195.45)***
Observations	12457	12456	17894
F-stat	134.04	121.93	227.75
R-squared	0.22	0.22	0.26
Note 1: Absolute value of t statistics in parentheses			
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%			

Table 47. OLS Estimates of O-3 PI Models

	Model-1	Model-2	Model-3	Model-4
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married	0.168	N/A	0.130	0.565
	(3.58)***	N/A	(2.49)**	(10.28)***
Divorced	0.212	N/A	0.201	N/A
	(1.06)	N/A	(0.86)	N/A
Accumulated Years in Marriage	N/A	0.064	N/A	N/A
	N/A	(4.89)***	N/A	N/A
Number of non-spousal dependents	N/A	N/A	0.396	N/A
	N/A	N/A	(6.48)***	N/A
To Be Married	N/A	N/A		0.850
	N/A	N/A		(13.66)***
Married and have non-spousal dependents	N/A	N/A	-0.248	N/A
	N/A	N/A	(3.53)***	N/A
Divorced and have non-spousal dependents	N/A	N/A	-0.256	N/A
	N/A	N/A	(1.22)	N/A
Commissioning age	-0.081	-0.082	-0.089	-0.080
	(5.44)***	(5.47)***	(5.89)***	(5.42)***
African American	-0.136	-0.111	-0.152	-0.144
	(1.21)	(0.96)	(1.35)	(1.28)
Hispanic	0.006	0.040	-0.005	-0.001
	(0.04)	(0.29)	(0.04)	(0.01)
Other Race	-0.100	-0.096	-0.105	-0.104
	(0.72)	(0.66)	(0.75)	(0.75)
Gct Score	-0.012	-0.012	-0.011	-0.011
	(4.54)***	(4.54)***	(4.46)***	(4.48)***
TBS Class-rank percentile	0.018	0.019	0.018	0.018
	(20.67)***	(21.89)***	(20.37)***	(20.09)***
Commissioning Source-NROTC	0.056	-0.005	0.054	0.064
	(0.66)	(0.06)	(0.63)	(0.76)
Commissioning Source-PLC	-0.240	-0.338	-0.235	-0.229
	(3.03)***	(4.27)***	(2.98)***	(2.92)***

Table 47. OLS Estimates of O-3 PI Models (Cont.)

Commissioning Source-OCC	-0.174	-0.306	-0.169	-0.150
	(1.91)*	(3.37)***	(1.85)*	(1.66)*
Commissioning Source-MECEP	0.134	0.003	0.043	0.157
	(0.86)	(0.02)	(0.27)	(1.02)
Commissioning Source-ECP	-0.195	-0.287	-0.229	-0.171
	(1.26)	(1.89)*	(1.48)	(1.11)
Commissioning Fiscal Year	YES	YES	YES	YES
Constant	98.398	99.696	98.442	98.061
	(137.93)***	(201.12)***	(137.97)***	(138.30)***
Observations	13768	14220	13767	13767
F-stat	72.94	82.71	67.87	80.77
R-squared	0.13	0.13	0.13	0.14
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Table 48. OLS Estimates of O-4 PI Models

	Model-1	Model-2	Model-3	Model-4
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married	0.062	N/A	0.034	0.190
	(1.61)	N/A	(0.77)	(4.07)***
Divorced	0.124	N/A	0.093	N/A
	(0.97)	N/A	(0.56)	N/A
Accumulated Years in Marriage	N/A	0.003	N/A	N/A
	N/A	(0.62)	N/A	N/A
Number of non-spousal dependents	N/A	N/A	0.118	N/A
	N/A	N/A	(2.74)***	N/A
To Be Married	N/A	N/A		0.335
	N/A	N/A		(5.41)***
Married and have non-spousal dependents	N/A	N/A	-0.053	N/A
	N/A	N/A	(1.14)	N/A
Divorced and have non-spousal dependents	N/A	N/A	-0.028	N/A
	N/A	N/A	(0.20)	N/A
Commissioning age	-0.030	-0.025	-0.034	-0.029
	(2.56)**	(2.16)**	(2.90)***	(2.53)**
African American	-0.101	-0.079	-0.103	-0.089
	(1.11)	(0.87)	(1.13)	(0.98)
Hispanic	0.135	0.155	0.125	0.140
	(1.17)	(1.35)	(1.09)	(1.22)
Other Race	0.076	-0.032	0.074	0.062
	(0.65)	(0.28)	(0.63)	(0.53)
Gct Score	-0.002	-0.002	-0.002	-0.002
	(1.14)	(1.06)	(1.06)	(0.87)
TBS Class-rank percentile	0.003	0.004	0.003	0.003
	(4.89)***	(5.60)***	(4.75)***	(4.93)***
Commissioning Source-NROTC	-0.102	-0.112	-0.099	-0.103
	(1.58)	(1.73)*	(1.54)	(1.60)
Commissioning Source-PLC	-0.108	-0.124	-0.101	-0.093
	(1.77)*	(2.03)**	(1.65)*	(1.52)
Commissioning Source-OCC	-0.018	-0.075	-0.010	-0.019
	(0.26)	(1.05)	(0.14)	(0.26)

Table 48. OLS Estimates of O-4 PI Models (Cont.)

Commissioning Source-MECEP	0.016	-0.001	-0.007	0.038
	(0.14)	(0.01)	(0.06)	(0.34)
Commissioning Source-ECP	-0.182	-0.183	-0.189	-0.138
	(1.67)*	(1.70)*	(1.73)*	(1.28)
Commissioning Fiscal Year	YES	YES	YES	YES
Constant	100.258	100.144	100.264	100.028
	(265.29)***	(268.43)***	(264.67)***	(264.46)***
Observations	6741	7020	6741	6863
F-Stat	6.77	7.47	6.66	8.34
R-squared	0.02	0.02	0.03	0.03
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Table 49. OLS Estimates of O-4 PI Models

	Model-1	Model-2	Model-3	Model-4
	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Married	0.060	N/A	0.064	0.099
	(2.89)***	N/A	(2.51)**	(4.15)***
Divorced	0.014	N/A	0.015	N/A
	(0.37)	N/A	(0.26)	N/A
Accumulated Years in Marriage	N/A	0.003	N/A	N/A
	N/A	(1.14)	N/A	N/A
Number of non-spousal dependents	N/A	N/A	0.010	N/A
	N/A	N/A	(0.41)	N/A
To Be Married	N/A	N/A		0.090
	N/A	N/A		(2.68)***
Married and have non-spousal dependents	N/A	N/A	-0.010	N/A
	N/A	N/A	(0.39)	N/A
Divorced and have non-spousal dependents	N/A	N/A	-0.008	N/A
	N/A	N/A	(0.20)	N/A
Commissioning age	-0.001	-0.006	-0.001	0.001
	(0.10)	(0.68)	(0.10)	(0.11)
African American	-0.023	0.001	-0.023	-0.023
	(0.70)	(0.01)	(0.69)	(0.71)
Hispanic	0.013	0.032	0.013	0.013
	(0.31)	(0.33)	(0.30)	(0.32)
Other Race	0.018	0.049	0.017	0.008
	(0.36)	(0.45)	(0.34)	(0.16)
Gct Score	0.001	0.001	0.001	-0.001
	(0.01)	(0.08)	(0.00)	(0.07)
TBS Class-rank percentile	0.001	0.001	0.001	0.001
	(1.33)	(0.08)	(1.33)	(1.26)
Commissioning Source-NROTC	0.001	-0.006	0.002	0.003
	(0.07)	(0.14)	(0.08)	(0.13)
Commissioning Source-PLC	-0.005	0.010	-0.005	-0.003
	(0.25)	(0.24)	(0.26)	(0.18)
Commissioning Source-OCC	0.011	-0.044	0.011	0.009
	(0.53)	(0.94)	(0.52)	(0.44)

Table 49. OLS Estimates of O-4 PI Models (Cont.)

Commissioning Source-MECEP	0.008	0.038	0.008	0.009
	(0.17)	(0.35)	(0.16)	(0.18)
Commissioning Source-ECP	-0.038	-0.008	-0.038	-0.041
	(1.16)	(0.11)	(1.17)	(1.24)
Commissioning Fiscal Year	YES	YES	YES	YES
Constant	99.906	99.992	99.902	99.857
	(803.61)***	(371.56)***	(799.81)***	(799.22)***
Observations	1095	1192	1095	1095
F-stat	1.38	1.12	1.17	1.83
R-squared	0.02	0.01	0.02	0.03
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

APPENDIX B. HECKMAN ESTIMATES OF O-4 AND O-5 PI MODELS

Table 50. Heckman Estimates of O-4 PI Models

	Model 1		Model 2	
	Hypothesis 1		Hypothesis 2	
	PI_o4	survived_ o4brd	PI_o4	survived_ o4brd
Married at O-3	0.103	N/A	0.064	N/A
	(1.87)*	N/A	(0.99)	N/A
Divorced at O-3	0.035	N/A	0.004	N/A
	(0.17)	N/A	(0.01)	N/A
Number of non-spousal dependents at O-4	N/A	N/A	0.172	N/A
	N/A	N/A	(3.16)***	N/A
To Be Married at O-4	N/A	N/A		N/A
	N/A	N/A		N/A
Married and have non-spousal dependents	N/A	N/A	-0.071	N/A
	N/A	N/A	(1.17)	N/A
Divorced and have non-spousal dependents	N/A	N/A	-0.017	N/A
	N/A	N/A	(0.07)	N/A
Commissioning age	-0.056	0.030	-0.062	0.030
	(3.21)***	(3.25)***	(3.56)***	(3.25)***
African American	-0.142	-0.115	-0.132	-0.115
	(1.02)	(1.80)*	(0.95)	(1.80)*
Hispanic	0.305	-0.161	0.280	-0.161
	(1.61)	(1.87)*	(1.47)	(1.87)*
Other race	0.206	-0.171	0.206	-0.171
	(1.09)	(1.94)*	(1.09)	(1.94)*
TBS Class-rank percentile	0.003	0.009	0.002	0.009
	(1.71)*	(18.83)***	(1.43)	(18.83)***
Commissioning Source-NROTC	-0.122	-0.010	-0.112	-0.010
	(1.25)	(0.19)	(1.15)	(0.19)

Table 50. Heckman Estimates of O-4 PI Models (Cont.)

Commissioning Source-PLC	-0.084	-0.040	-0.067	-0.040
	(0.96)	(0.86)	(0.77)	(0.86)
Commissioning Source-OCC	0.092	-0.170	0.114	-0.170
	(0.87)	(3.25)***	(1.07)	(3.25)***
Commissioning Source-MECEP	-0.156	0.459	-0.194	0.459
	(0.83)	(3.57)***	(1.03)	(3.57)***
Commissioning Source-ECP	-0.312	0.243	-0.322	0.243
	(1.96)*	(2.29)**	(2.02)**	(2.29)**
Commissioning Fiscal Years	YES	NO	YES	NO
Prior Enlisted Service	N/A	0.009	N/A	0.009
	N/A	(0.13)	N/A	(0.13)
GCT score	N/A	-0.005	N/A	-0.005
	N/A	(3.62)***	N/A	(3.62)***
Ground Support MOS	N/A	-0.065	N/A	-0.065
	N/A	(1.44)	N/A	(1.44)
Combat MOS	N/A	-0.034	N/A	-0.034
	N/A	(0.80)	N/A	(0.80)
Aviation MOS	N/A	0.301	N/A	0.301
	N/A	(6.89)***	N/A	(6.89)***
Aviation Support MOS	N/A	-0.147	N/A	-0.147
	N/A	(2.76)***	N/A	(2.76)***
Lambda (λ)	-.430	N/A	-.721	N/A
	(.237)*	N/A	(.280)***	N/A
Constant	100.799	-0.601	100.879	-0.601
	(192.79)***	(2.06)**	(192.09)***	(2.06)**
Observations	10013	10013	10013	10013

Table 50. Heckman Estimates of O-4 PI Models (Cont.)

	Model 3		Model 4	
	Hypothesis 3		Hypothesis 4	
	PI_o4	Survived _o4brd	PI_o4	Survived _o4brd
Married at O-3	N/A	N/A	0.415	N/A
	N/A	N/A	(6.39)***	N/A
To Be Married at O-4	N/A	N/A	0.646	N/A
	N/A	N/A	(7.73)***	N/A
Accumulated years of marriage until O-4	0.005	N/A	N/A	N/A
	(0.83)	N/A	N/A	N/A
Commissioning age	-0.053	0.027	-0.055	0.027
	(3.04)***	(2.97)***	(3.20)***	(2.95)***
African American	-0.078	-0.134	-0.083	-0.131
	(0.56)	(2.13)**	(0.60)	(2.09)**
Hispanic	0.383	-0.195	0.381	-0.192
	(1.99)**	(2.28)**	(1.99)**	(2.24)**
Other race	0.033	-0.154	0.049	-0.151
	(0.18)	(1.80)*	(0.26)	(1.76)*
TBS Class-rank percentile	0.002	0.009	0.001	0.009
	(1.16)	(18.17)***	(0.80)	(18.16)***
Commissioning Source-NROTC	-0.137	0.001	-0.119	-0.001
	(1.40)	(0.02)	(1.21)	(0.03)
Commissioning Source-PLC	-0.120	0.001	-0.059	-0.002
	(1.36)	(0.02)	(0.66)	(0.04)
Commissioning Source-OCC	0.022	-0.118	0.084	-0.120
	(0.21)	(2.28)**	(0.80)	(2.33)**
Commissioning Source-MECEP	-0.240	0.434	-0.231	0.435
	(1.24)	(3.41)***	(1.19)	(3.41)***
Commissioning Source-ECP	-0.362	0.261	-0.328	0.260
	(2.26)**	(2.51)**	(2.04)**	(2.50)**
Commissioning Fiscal Years	YES	NO	YES	NO
Prior Enlisted Service	N/A	0.043	N/A	0.039
	N/A	(0.64)	N/A	(0.58)

Table 50. Heckman Estimates of O-4 PI Models (Cont.)

GCT score	N/A	-0.005	N/A	-0.005
	N/A	(3.43)***	N/A	(3.51)***
Ground Support MOS	N/A	-0.063	N/A	-0.062
	N/A	(1.40)	N/A	(1.40)
Combat MOS	N/A	-0.027	N/A	-0.026
	N/A	(0.66)	N/A	(0.63)
Aviation MOS	N/A	0.255	N/A	0.257
	N/A	(5.92)***	N/A	(5.94)***
Aviation Support MOS	N/A	-0.114	N/A	-0.118
	N/A	(2.21)**	N/A	(2.28)**
Lambda (λ)	-.476	N/A	-.769	N/A
	(.237)**	N/A	(.279)***	N/A
Constant	101.059	-0.537	100.790	-0.520
	(180.52)***	(1.88)*	(179.81)***	(1.82)*
Observations	10276	10276	10252	10252
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Table 51. Heckman Estimates of O-5 PI Models

	Model 1		Model 2	
	Hypothesis 1		Hypothesis 2	
	PI_o5	Survived _o5brd	PI_o5	Survived _o5brd
Married at O-4	0.153	N/A	0.207	N/A
	(2.58)**	N/A	(3.02)***	N/A
Divorced at O-4	0.043	N/A	N/A	N/A
	(0.32)	N/A	N/A	N/A
To Be Married at O-5	N/A	N/A	0.159	N/A
	N/A	N/A	(1.49)	N/A
Commissioning age	0.003	-0.035	0.005	-0.035
	(0.22)	(1.60)	(0.39)	(1.60)
African American	-0.142	-0.200	-0.129	-0.200
	(1.18)	(1.10)	(1.10)	(1.10)
Hispanic	0.048	-0.120	0.049	-0.120
	(0.31)	(0.45)	(0.32)	(0.45)
Other race	-0.003	0.148	-0.003	0.148
	(0.02)	(0.63)	(0.02)	(0.63)
TBS Class-rank percentile	0.001	0.010	0.001	0.010
	(0.22)	(8.70)***	(0.11)	(8.70)***
Commissioning Source-NROTC	0.013	-0.060	0.019	-0.060
	(0.21)	(0.54)	(0.31)	(0.54)
Commissioning Source-PLC	-0.003	-0.222	0.004	-0.222
	(0.05)	(2.17)**	(0.07)	(2.17)**
Commissioning Source-OCC	0.043	-0.271	0.042	-0.271
	(0.51)	(2.37)**	(0.51)	(2.37)**
Commissioning Source-MECEP	0.191	-0.678	0.189	-0.678
	(1.15)	(2.17)**	(1.14)	(2.17)**
Commissioning Source-ECP	-0.084	0.021	-0.084	0.021
	(0.86)	(0.08)	(0.86)	(0.08)
Commissioning Fiscal Years	YES	NO	YES	NO
Prior Enlisted Service	N/A	0.255	N/A	0.255
	N/A	(1.08)	N/A	(1.08)
GCT score	N/A	-0.007	N/A	-0.007
	N/A	(2.16)**	N/A	(2.16)**
Ground Support MOS	N/A	-0.212	N/A	-0.212
	N/A	(1.85)*	N/A	(1.85)*

Table 51. Heckman Estimates of O-5 PI Models (Cont.)

Combat MOS	N/A	-0.019	N/A	-0.019
	N/A	(0.19)	N/A	(0.19)
Aviation MOS	N/A	-0.033	N/A	-0.033
	N/A	(0.32)	N/A	(0.32)
Aviation Support MOS	N/A	-0.021	N/A	-0.021
	N/A	(0.15)	N/A	(0.15)
Lambda (λ)	-.047	N/A	-.072	N/A
	(.231)	N/A	(.232)	N/A
Constant	99.816	-0.010	99.769	-0.010
	(203.71)***	(0.01)	(203.29)***	(0.01)
Observations	3979	3979	3979	3979
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Table 51. Heckman Estimates of O-5 PI Models (Cont.)

	Model 3		Model 4	
	Hypothesis 3		Hypothesis 4	
	PI_o5	Survived _o5brd	PI_o5	Survived _o5brd
Married at O-4	N/A	N/A	0.172	N/A
	N/A	N/A	(2.26)**	N/A
Divorced at O-4	N/A	N/A	0.159	N/A
	N/A	N/A	(0.70)	N/A
Number of non-spousal dependents at O-5	N/A	N/A	0.027	N/A
	N/A	N/A	(0.41)	N/A
Married and have non-spousal dependents at O-5	N/A	N/A	-0.030	N/A
	N/A	N/A	(0.43)	N/A
Divorced and have non-spousal dependents at O-5	N/A	N/A	-0.090	N/A
	N/A	N/A	(0.70)	N/A
Accumulated years of marriage until O-5	0.004	N/A	N/A	N/A
	(0.67)	N/A	N/A	N/A
Commissioning age	-0.011	-0.035	0.003	-0.035
	(0.39)	(1.67)*	(0.23)	(1.60)
African American	-0.123	-0.287	-0.150	-0.200
	(0.45)	(1.60)	(1.23)	(1.10)

Table 51. Heckman Estimates of O-5 PI Models (Cont.)

Hispanic	0.132	-0.219	0.050	-0.120
	(0.36)	(0.84)	(0.32)	(0.45)
Other race	0.106	0.064	-0.003	0.148
	(0.36)	(0.27)	(0.02)	(0.63)
TBS Class-rank percentile	-0.002	0.010	0.001	0.010
	(0.51)	(9.21)***	(0.21)	(8.70)***
Commissioning Source-NROTC	-0.008	-0.046	0.015	-0.060
	(0.07)	(0.44)	(0.26)	(0.54)
Commissioning Source-PLC	0.080	-0.203	0.001	-0.222
	(0.59)	(2.10)**	(0.01)	(2.17)**
Commissioning Source-OCC	-0.101	-0.258	0.044	-0.271
	(0.59)	(2.39)**	(0.53)	(2.37)**
Commissioning Source-MECEP	0.413	-0.660	0.200	-0.678
	(1.06)	(2.13)**	(1.20)	(2.17)**
Commissioning Source-ECP	-0.035	0.041	-0.084	0.021
	(0.17)	(0.15)	(0.86)	(0.08)
Commissioning Fiscal Years	YES	NO	YES	NO
Prior Enlisted Service		0.152		0.255
		(0.65)		(1.08)
GCT score		-0.006		-0.007
		(2.02)**		(2.16)**
Ground Support MOS		-0.270		-0.212
		(2.54)**		(1.85)*
Combat MOS		-0.159		-0.019
		(1.67)*		(0.19)
Aviation MOS		-0.080		-0.033
		(0.85)		(0.32)
Aviation Support MOS		-0.079		-0.021
		(0.62)		(0.15)
Lambda (λ)	-.266		-.052	
	(.499)		(.233)	
Constant	100.640	0.049	99.808	-0.010
	(105.24)***	(0.08)	(203.52)***	(0.01)
Observations	4047	4047	3979	3979
Note 1: Absolute value of t statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

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APPENDIX C. MAXIMUM LIKELIHOOD PROBIT ESTIMATION (MLPE) WITH SAMPLE SELECTION RESULTS

Table 52. MLPE with Sample Selection Estimates of Promotion to O-4 Models

	Model 1		Model 2	
	Hypothesis 1		Hypothesis 2	
	prom_o4	survived_o4brd	prom_o4	survived_o4brd
Married at O-3	0.129	N/A	N/A	N/A
	(3.94)***	N/A	N/A	N/A
Accumulated years in marriage until O-4 board	N/A	N/A	0.009	N/A
	N/A	N/A	(2.47)**	N/A
African American	-0.081	-0.035	-0.076	-0.034
	(1.05)	(0.67)	(0.99)	(0.67)
Hispanic	-0.119	-0.033	-0.115	-0.037
	(1.22)	(0.48)	(1.18)	(0.55)
Other race	-0.047	-0.009	-0.048	-0.014
	(0.46)	(0.13)	(0.47)	(0.20)
TBS Class Rank Percentile	0.007	0.006	0.007	0.006
	(10.75)***	(13.54)***	(10.68)***	(13.55)***
Commissioning Source-NROTC	-0.101	0.054	-0.102	0.055
	(1.69)*	(1.30)	(1.70)*	(1.32)
Commissioning Source-PLC	-0.112	-0.064	-0.116	-0.062
	(2.05)**	(1.70)*	(2.11)**	(1.64)
Commissioning Source-OCC	0.016	-0.286	0.017	-0.282
	(0.26)	(6.51)***	(0.27)	(6.44)***
Commissioning Source-MECEP	0.136	0.351	0.124	0.356
	(1.26)	(3.37)***	(1.15)	(3.42)***
Commissioning Source-ECP	0.197	-0.076	0.184	-0.070
	(1.98)**	(0.87)	(1.85)*	(0.81)
Commissioning Age	N/A	0.045	N/A	0.045
	N/A	(5.83)***	N/A	(5.87)***
Recommended for Accelerated promotion	N/A	0.535	N/A	0.536
	N/A	(4.88)***	N/A	(4.89)***

Table 52. MLPE with Sample Selection Estimates of Promotion to O-4 Models (cont.)

Not Recommended for promotion	N/A	-0.931	N/A	-0.941
	N/A	(6.36)***	N/A	(6.41)***
Prior Enlisted Service	N/A	0.267	N/A	0.266
	N/A	(4.95)***	N/A	(4.93)***
Ground Support MOS	N/A	-0.028	N/A	-0.031
	N/A	(0.89)	N/A	(1.00)
Combat MOS	N/A	-0.023	N/A	-0.028
	N/A	(0.63)	N/A	(0.76)
Aviation MOS	N/A	0.376	N/A	0.371
	N/A	(13.76)***	N/A	(13.55)***
Aviation Support MOS	N/A	-0.140	N/A	-0.141
	N/A	(3.54)***	N/A	(3.57)***
Constant	0.297	-1.086	0.348	-1.087
	(2.63)***	(6.23)***	(3.04)***	(6.25)***
Observations	14116	14116	14170	14170
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

Table 52. MLPE with Sample Selection Estimates of Promotion to O-4 Models (cont.)

	Model 3		Model 4	
	Hypothesis 3		Hypothesis 4	
	prom_o4	survived_o4brd	prom_o4	survived_o4brd
Married at O-3	N/A	N/A	0.143	N/A
	N/A	N/A	(4.31)***	N/A
To be Married at O-3	N/A	N/A	0.341	N/A
	N/A	N/A	(8.86)***	N/A
Number of non-spousal dependent at O-4	0.218	N/A		N/A
	(11.08)***			
African American	-0.089	-0.036	-0.080	-0.034
	(1.16)	(0.70)	(1.04)	(0.66)
Hispanic	-0.134	-0.037	-0.137	-0.033
	(1.37)	(0.55)	(1.40)	(0.48)
Other race	-0.025	-0.015	-0.074	-0.009
	(0.25)	(0.21)	(0.72)	(0.13)
TBS Class Rank Percentile	0.007	0.006	0.007	0.006
	(10.77)***	(13.57)***	(10.70)***	(13.54)***

Table 52. MLPE with Sample Selection Estimates of Promotion to O-4 Models (cont.)

Commissioning Source-NROTC	-0.095	0.055	-0.097	0.054
	(1.57)	(1.31)	(1.61)	(1.30)
Commissioning Source-PLC	-0.116	-0.062	-0.098	-0.064
	(2.13)**	(1.65)*	(1.79)*	(1.69)*
Commissioning Source-OCC	-0.013	-0.286	0.043	-0.284
	(0.20)	(6.52)***	(0.68)	(6.46)***
Commissioning Source-MECEP	-0.027	0.347	0.219	0.357
	(0.25)	(3.34)***	(2.04)**	(3.42)***
Commissioning Source-ECP	0.094	-0.082	0.262	-0.071
	(0.94)	(0.95)	(2.64)***	(0.81)
Commissioning Age	N/A	0.046	N/A	0.044
	N/A	(6.09)***	N/A	(5.68)***
Recommended for Accelerated promotion	N/A	0.542	N/A	0.528
	N/A	(4.99)***	N/A	(4.81)***
Not Recommended for promotion	N/A	-0.929	N/A	-0.927
	N/A	(6.37)***	N/A	(6.35)***
Prior Enlisted Service	N/A	0.272	N/A	0.266
	N/A	(5.09)***	N/A	(4.95)***
Ground Support MOS	N/A	-0.027	N/A	-0.028
	N/A	(0.90)	N/A	(0.92)
Combat MOS	N/A	-0.028	N/A	-0.023
	N/A	(0.78)	N/A	(0.65)
Aviation MOS	N/A	0.368	N/A	0.378
	N/A	(13.46)***	N/A	(13.85)***
Aviation Support MOS	N/A	-0.141	N/A	-0.141
	N/A	(3.59)***	N/A	(3.56)***
Constant	0.231	-1.116	0.172	-1.064
	(2.13)**	(6.47)***	(1.57)	(6.09)***
Observations	14170	14170	14116	14116
Absolute value of z statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

Table 53. MLPE with Sample Selection Estimates of Promotion to O-5 Models

	Hypothesis 1		Hypothesis 2	
	prom_o5	survived_o5brd	prom_o5	survived_o5brd
Married at O-4	0.085	N/A	N/A	N/A
	(2.07)**	N/A	N/A	N/A
Accumulated years in marriage until O-5 board	N/A	N/A	0.001	N/A
	N/A	N/A	(0.27)	N/A
African American	0.032	-0.027	-0.023	-0.043
	(0.31)	(0.29)	(0.22)	(0.46)
Hispanic	0.172	0.063	0.107	0.039
	(1.11)	(0.43)	(0.69)	(0.27)
Other race	-0.042	-0.008	-0.046	-0.025
	(0.24)	(0.05)	(0.27)	(0.17)
TBS Class Rank Percentile	0.010	0.009	0.009	0.008
	(13.16)***	(12.68)***	(13.16)***	(12.59)***
Recommended for Accelerated promotion	0.679	0.688	0.661	0.670
	(6.27)***	(6.24)***	(6.19)***	(6.14)***
Not Recommended for promotion	-5.211	-0.832	-8.190	-0.876
	(0.01)	(2.90)***	(.)	(3.07)***
Commissioning Source-NROTC	-0.025	-0.006	-0.015	0.004
	(0.33)	(0.08)	(0.20)	(0.06)
Commissioning Source-PLC	-0.108	-0.086	-0.095	-0.074
	(1.58)	(1.34)	(1.43)	(1.17)
Commissioning Source-OCC	-0.136	-0.155	-0.137	-0.153
	(1.93)*	(2.28)**	(1.99)**	(2.29)**
Commissioning Source-MECEP	-0.655	-0.909	-0.686	-0.946
	(4.33)***	(5.54)***	(4.55)***	(5.82)***
Commissioning Source-ECP	-0.103	-0.403	-0.127	-0.423
	(0.92)	(2.79)***	(1.15)	(2.97)***
Commissioning Age	N/A	0.043	N/A	0.041
	N/A	(4.98)***	N/A	(4.90)***

Table 53. MLPE with Sample Selection Estimates of Promotion to O-5 Models (Cont.)

Prior Enlisted Service	N/A	0.428	N/A	0.439
	N/A	(4.06)***	N/A	(4.24)***
Ground Support MOS	N/A	-0.013	N/A	-0.013
	N/A	(0.37)	N/A	(0.38)
Combat MOS	N/A	-0.033	N/A	-0.036
	N/A	(0.77)	N/A	(0.87)
Aviation MOS	N/A	-0.049	N/A	-0.046
	N/A	(1.72)*	N/A	(1.68)*
Aviation Support MOS	N/A	-0.087	N/A	-0.076
	N/A	(1.87)*	N/A	(1.67)*
Constant	-1.345	-1.853	-1.204	-1.762
	(16.11)***	(9.17)***	(15.78)***	(8.91)***
Observations	5436	5436	5563	5563
Absolute value of z statistics in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

Table 53. MLPE with Sample Selection Estimates of Promotion to O-5 Models (Cont.)

	Hypothesis 3		Hypothesis 4	
	prom_o5	survived_o5brd	prom_o5	survived_o5brd
Married at O-4	N/A	N/A	0.072	N/A
	N/A	N/A	(1.72)*	N/A
To be Married at O-4	N/A	N/A	0.056	N/A
	N/A	N/A	(1.97)**	N/A
Number of non-spousal dependent at O-5	0.082	N/A	N/A	N/A
	(6.10)***	N/A	N/A	N/A
African American	0.001	-0.053	0.030	-0.025
	(0.01)	(0.56)	(0.29)	(0.26)
Hispanic	0.076	0.043	0.171	0.064
	(0.49)	(0.29)	(1.11)	(0.43)
Other race	-0.021	-0.035	-0.056	-0.007
	(0.13)	(0.23)	(0.33)	(0.05)
TBS Class Rank Percentile	0.009	0.008	0.010	0.009
	(13.07)***	(12.64)***	(13.00)***	(12.70)***

Table 53. MLPE with Sample Selection Estimates of Promotion to O-5 Models (Cont.)

Recommended for Accelerated promotion	0.634	0.678	0.680	0.687
	(5.92)***	(6.22)***	(6.17)***	(6.18)***
Not Recommended for promotion	-8.410	-0.879	-7.886	-0.830
	(.)	(3.07)***	(.)	(2.85)***
Commissioning Source-NROTC	-0.005	0.002	-0.021	-0.005
	(0.06)	(0.03)	(0.28)	(0.07)
Commissioning Source-PLC	-0.087	-0.078	-0.103	-0.085
	(1.30)	(1.24)	(1.50)	(1.32)
Commissioning Source-OCC	-0.140	-0.163	-0.128	-0.153
	(2.02)**	(2.44)**	(1.81)*	(2.25)**
Commissioning Source-MECEP	-0.733	-0.969	-0.638	-0.905
	(4.84)***	(5.99)***	(4.20)***	(5.51)***
Commissioning Source-ECP	-0.151	-0.438	-0.087	-0.400
	(1.36)	(3.10)***	(0.78)	(2.77)***
Commissioning Age	N/A	0.045	N/A	0.042
	N/A	(5.45)***	N/A	(4.71)***
Prior Enlisted Service	N/A	0.439	N/A	0.428
	N/A	(4.29)***	N/A	(4.03)***
Ground Support MOS	N/A	-0.006	N/A	-0.015
	N/A	(0.17)	N/A	(0.44)
Combat MOS	N/A	-0.026	N/A	-0.035
	N/A	(0.62)	N/A	(0.82)
Aviation MOS	N/A	-0.055	N/A	-0.047
	N/A	(2.03)**	N/A	(1.67)*
Aviation Support MOS	N/A	-0.081	N/A	-0.082
	N/A	(1.77)*	N/A	(1.76)*
Constant	-1.328	-1.850	-1.348	-1.830
	(17.52)***	(9.48)***	(12.37)***	(8.08)***
Observations	5563	5563	5436	5436
Note 1: Absolute value of z statistics in parentheses				
Note 2: * significant at 10%; ** significant at 5%; *** significant at 1%				

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